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1.

The Electric Discharge of the Electric Eel, *Electrophorus electricus* (Linnaeus).

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(Plates I & II; Text-figures 1-6).

Introduction.

The electrical power developed by certain fishes has stirred the imagination of investigators since the earliest times, but an adequate, thorough, explanation of the phenomenon is still unavailable. Since there is still much to be explained in the physiology of skin and muscle, from which the electric organs of the various electric fishes are derived, we thought it well to attempt an explanation of the external manifestation by an analysis of the electrical currents and potentials as they may be examined at present and, perhaps, to suggest the internal electrical mechanism from this analysis. The present paper then, is largely concerned with the physics of the external electrical phenomena.

Of all the electric fishes the Electric Eel is the largest and develops most power, and to our minds offers the most suitable medium for investigation. Besides, the other electric fishes, Torpedo (*Raia*), *Malopterurus*, the Electric Mormyridae, and *Astroscopus*, are not so easily available to us as the eel, and do not withstand the necessary laboratory manipulation as well.

The Electric Eel is more or less circular in cross-section, depressed at the head and compressed at the tail. The length is roughly ten times the greatest diameter.

We are greatly indebted to Mr. C. M. Breder, Jr., and Dr. D. E. S. Brown for criticism and suggestions on the preparation of this paper; to Dr. R. F. Nigrelli for photographic assistance, and to Francesca LaMonte for bibliographic assistance.

Dr. Max Mapes Ellis (1913) describes the position of the electric organs of the fish rather fully and since the position is of some importance in the following discussion we think it advisable to quote him.

"There are three pairs of electric organs in *E. electricus*, the large electric organs, the secondary organs or the organs of Hunter, and the bundles of Sachs. The large organs and the organs of Hunter both begin a short distance behind the viscera and run nearly the whole length of the fish. The bundles of Sachs are found only in the posterior half of the fish. The large organ of each side is more or less quadrant shaped in cross-section, and is of greatest diameter about a centimeter back of its origin. It tapers gradually back of this point becoming more nearly circular in cross-section until it disappears a few centimeters from the end of the tail. It lies on each side of the haemal spine above the anal fin muscalature and below the muscle *ventralis*. In the region of its maximum size the top of each organ is on a level with the vertebral centra, but as the caudal end is approached, the dorsal portion of each organ lies more and more ventrad.

"The organ of Sachs consists of a series of bundles of fibers which resemble both muscle and electric tissue. From the middle of the body to the caudal end of the large electric organs, the organs of Sachs lie on a *dorso-lateral* surface of the latter, just below the muscle *ventralis*. The bundles of this organ wrap around the large electrical organ obliquely in a latero-ventral direction. They extend further ventrad as the caudal extremities of the large organ are neared. They finally close over the ends of these. The organs of Sachs increase in diameter caudad.

"The organs of Hunter are triangular in cross-section and much smaller than either of the other two pairs of organs. They are in the anal fin region and lie between the muscles *pinnalis analis externalis* and the muscles *pinnalis analis internalis*. Dorsally they are separated from the large organ by the remnants of the muscles *lateralis imus*. They taper off as their caudal ends are approached and terminate a few centimeters in front of the ends of the large organs."

Dr. Ellis reproduces plates, not included here, and continues with a description of the organs:

"Both the large organs and the organs of Hunter are composed of plates of tissue which run parallel to the large axis of the fish. In the large organs these plates are more or less arched ventrally in cross-section. In the small organs they are almost flat. The number of these plates seem to be rather constant in each organ, regardless of the size of the fish. Bois-Raymond (1881) (in Sachs, Zitteraal, p. 32) gives the following table:

Observer	Body length	Plates in Large Organ	Plates in Small Organ
Sachs	31 cm.	30	14-19
Knox	48.5	32	17
Pahlberg	68.5	32	13
Hunter	71	35	15
Kupffer and Keferstein	120	31	Not given
Humboldt	Not given	36	20
Sachs	Not given	30	14-19

"According to Sachs, who confirmed in general the work of Pacini, the large electric organs are made up of minute units about .14 mm. broad, which lie at right angles to the long axis of the plates. Each unit is divided near the center by a vertical partition. On the anterior face of this are several papillae which do not reach the wall of the unit. On the posterior face are fewer papillae which reach out to the wall of the unit. Between the latter are several minute papillae. It is on this side that each receives its nerve-fibers."

We see no reason to change these descriptions.

The Electric Eel is a sluggish fish, given to lying still in shallow water for long periods which are broken only to move to the surface of the water to gulp air, a process which is repeated at intervals of about four minutes. We have found these fish will drown if denied access to air for as little as fifteen minutes, a significant fact, perhaps, which might indicate a high oxidation rate, especially when discharging electricity.

The fish is reported from the fresh waters of northern South America, ranging from the Amazon Basin northward to the Orinoco Basin.

The first scientific reports of the electricity of the Electric Eel appear to be those of Richer, published 1729, and since then there are several hundred titles in the bibliography. For the sake of convenience we do not list the complete bibliography but suggest that reference to Dean's (1916-1923) Bibliography of Fishes be made.

However, it might be as well to discuss briefly some of the earlier findings, which, despite the crudity of the measuring apparatus available at the time, seem to us to be highly suggestive. We do not quite see, in view of many of these reports, how subsequent investigators, with still crude apparatus but apparatus which was a decided improvement over the original, should have become as confused as they apparently did, and it seems strange that with the improvement in electrical measuring instruments through the years the research into the nature of the discharge should have diminished considerably.

The first detailed evidence that the discharge was one of "electric fluid" seems to have been adduced by Williamson in 1775, who reports that he received an electrical shock through his finger when it was inserted in a stream of water flowing from a tank in which an Electric Eel had been disturbed. He further reports that a person insulated by standing on glass bottles could receive a shock by placing his hands in the water containing an eel. This report followed by two years the evidence that the Torpedo could give an electric shock, adduced by Walsh (1774) in letters to Benjamin Franklin.

Garden (1775), writing from America at the same period, offers some proof that the discharge was electrical and further, his description suggests that some of the five eels he saw were suffering from cataracts of the eye, a condition we find in most of our larger eels and which we suspect is due to the continual electric discharges. If this is so it is, apparently, the only self-inflicted effect of the electricity we have found to date.

It is at once apparent from most of this early literature that the eels available to the investigators were in poor condition; no doubt some of them were dying, a condition which might have had its advantages since the early investigators estimated the strength of the discharge by the sensation felt in the joints of the fingers, the hands, wrists, elbows, etc., following the methods of Cavendish's work on the Torpedo.

However, Schönbein (1841) reports seeing a fish in London in 1841 which had lived there for more than a year. This fish seemed to be quite healthy and gave an unexpectedly heavy shock which made a chain of people holding hands, the extreme left and right hands being placed in the water, leap into the air. This shock was repeated in rapid succession and he concluded that the eel could either divide its electricity or renew it at will. As against most previous investigators, Schönbein was able to report a spark across a small air-gap. He suggested that the nerve of the organ is an important, or perhaps the most important, part of the organ since if this is severed there is no more electricity. Matteucci (1844, 1847), on the contrary, thought that the nerves had little to do with it since he was able to dissect out part of the electric tissue and keep it for as long as eight days in an electrically active state. Humboldt (1806), however, had stated that until more was known of the general function of nerve it was useless to attempt further work. He compares the shock to that of a

Voltaic Pile and comments on the utter lack of effect on an electrometer. Letheby in 1843 endeavored to show that the electricity was derived from the brain and spinal cord and that the nervous and electrical forces were the same.

Faraday (1839, 1844) made a number of remarkably accurate observations on the Electric Eel—remarkable in their accuracy and in that his opportunities for observing the fish were extremely limited both because of the scarcity of specimens and because they were not his own and his use of them was limited by his unwillingness to risk damaging them by experiments. (Incidently there cannot have been many eels available anywhere at that time and the cost of those that were available comparatively high. Garden (1775) mentions fifty guineas as the price of the smallest of five ranging in size from two to about four feet which were presented for sale in Charleston about 1775. The price could not have been much, if anything, less in England, and the chance of obtaining them there much slimmer.) However, in spite of meager facilities, meager apparatus, and obviously sick fish, Faraday was able to determine that the current flowed from the head to the tail of the fish externally, that the largest shock was obtained from a point close behind the body proper and near the end of the tail. Our points of maximum potential correspond closely to this. Faraday also noted that the current must be of "low intensity but of great quantity," that the fish must be conscious of its own capabilities, and that the eel would quit discharging when it discovered that the electricity had no effect on the irritant. All these observations but the last, of which we have but *a priori* knowledge, fit nicely into the present calculations.

Pacini, 1853, postulated that the internal current of the electric organs must flow from the nutritive to the electrical surfaces of the cells, and since the nutritive surface is always posterior to the electric, the current must flow from tail to head.

Throughout this paper positions of electrodes and lengths of bodies of the eels measured are given in centimeters although they were actually measured in inches. The factor used in conversion is 2.5 cm. per inch instead of 2.54 cm. per inch. This is for convenience, on the one hand, and because the use of the more accurate figure would imply an exactitude of position impossible with such an animal. The total error involved by use of the conversion factor 2.5 is a little over one centimeter for the largest eel, negligible because it was not always possible to control the position of the animal during a series of discharges and observations to within one centimeter.

Our method of preparing the Electric Eel for taking the electrical readings is to remove it from the water, allow it to dry for a few minutes on a dry, insulated surface, and then put it into the measuring trough where it will usually lie quietly for as long as one hour, although we found it expedient to return the fish to the water at shorter periods. Heavy rubber gloves are worn when touching the eel, for the discharge may be dangerous, even with an exhausted eel which may have its voltage reduced by as much as one-third and which will not discharge as frequently as a fresh one.

Discussion.

Because the electric tissue is modified muscle tissue, it seems reasonable to suppose that the chemical processes by which energy is released in the electric organs are similar to those by which energy is released in muscles, but whereas in muscles most of the energy made available by the chemical transformations is released as mechanical work and only a minute fraction is released as electrical energy, in the electric organs this ratio is reversed and a large part of the energy is used to produce an electric discharge. On this supposition, the principal consequence of the modifica-

tion of muscle tissue into electric tissue would be to provide an organization of the cells in an electric network to make possible a discharge in cascade, so combining the cellular electromotive forces as to produce voltages more than a thousand times greater than those developed in ordinary muscular activity.

It does not seem necessarily true that the action of electric tissue is more complex than that of muscle tissue. On the contrary, there is reason to expect that it will be more easily understood. For it seems reasonable to suppose that muscular activity is a conversion of energy in two stages, first from the chemical form to the electrical, then from the electrical form to the mechanical. If this be true, then the action of electric tissue may show the isolated first stage of muscular action, and study of the transformation of energy in electric organs may be important for understanding the initial phase of muscular activity.

Since the skin of the eel and the tissue surrounding the electric organs are electrically conducting, it is possible to study the discharge by connecting the terminals of a suitable measuring instrument to wires in contact with the skin. When potential differences are measured without drawing appreciable current, as was the case in most of our observations, they are found only between points on the skin which include between them some longitudinal segment of one of the electric organs. (The points of contact with the skin must not both be anterior nor both be posterior to the discharging organ, and they must not both be on a common circumference of the eel.) If the points of contact are far enough apart to include between them the whole lengths of the electric organs, no appreciable change is made in the observed voltages by having them still farther apart.

When no appreciable current is drawn, that is, when the eel is on "open circuit" except for the leakage of current through its own tissue, an anterior point on its skin is always during the discharge electrically positive with respect to a posterior portion, which is in accordance with Pacini's rule.

When considerable current is drawn, the potential distribution over the skin of the eel is naturally modified by the flow of current in the neighborhood of the electrodes. In one of the few experiments we made in which considerable currents were drawn, an odd effect was noticed. The eel being out of the water and in contact with certain wires which offered a highly conducting path between anterior and posterior parts, it was gently prodded to make it discharge. After about five minutes of intermittent discharge, the skin over the posterior, electrically negative parts was observed to be bleached, where it touched the wires, to a shade much lighter than that elsewhere on the body. The eel was then returned to the water. After some ten or fifteen minutes similar sharply defined bleached areas were observed where the skin over the anterior parts had formerly touched the wires. With these connections the current density may have attained instantaneous values of the order of 0.1 ampere per cm.^{2} of skin, as may be inferred from the area in contact and certain observations (to be described later in this paper) made to determine the power of the discharge. Although such a current density must be much greater than any produced when the eel discharges under water and the current flows through its whole skin, the eel, nevertheless, showed no effects of the discharge beside the bleaching, and the bleached areas soon returned to the normal color.

Eilenfeld, using a string galvanometer of short period, has measured the peak voltages obtained between the extremities of a number of electric eels. He has reported the existence of two distinct peak voltages developed by any one eel. Observations previously reported[1] by two of the present

[1] Coates, C. W., and Cox, R. T. Preliminary Note on the Nature of the Electrical Discharges of the Electric Eel, *Electrophorus electricus* (Linnaeus). *Zoologica*, New York, 1936, Vol. 21, No. 11, pp. 125-128.

authors have confirmed this. We have not observed voltages as high as some of those reported by Eilenfeld. From observations under various conditions on a number of eels, we conclude that the maximum voltage by no means increases proportionately with the length of the eel. A potential difference of nearly 200 volts was developed by an eel 29 cm. long, but no voltages greater than about 300 volts have been found with larger eels, though observations have been made out of water on open circuit on eels ranging in length to about a meter and in water on eels as long as 240 cm.

The cathode-ray oscillograph, by reason of its almost instantaneous response to an applied voltage, is especially suited to observations of electric discharges in tissue. Its essential part is a vacuum tube in which a well defined beam of electrons, accelerated by a potential difference of several hundred volts, passes between flat electrodes to strike a fluorescent screen. The electrodes are commonly in the form of rectangular plates. A pair of such plates being fixed one on either side of the beam with their surfaces parallel to it, a difference of potential established between them will cause a deflection of the electron beam approximately proportional to the applied voltage. If the voltage is applied suddenly, the luminous spot in which the electron beam strikes the fluorescent screen will move rapidly across the screen, and the persistence of the fluorescence and of the visual sensation will give the appearance of a luminous streak. This trace can be photographed with a lens sufficiently rapid. We have used an F2 and an F3.5 lens with Eastman Super X film.

Commonly, the tube is equipped with two pairs of deflecting plates, mutually at right angles, to which voltages can be applied at the same time. A usual practice is to connect a "sweep circuit" to the horizontally deflecting pair of plates. This circuit generates a voltage which increases uniformly in time to a certain value and then returns very rapidly to zero. Under the action of this voltage, the luminous spot moves horizontally across the fluorescent screen at a nearly uniform rate for a certain distance and then returns almost instantaneously to its starting point. A transient voltage under investigation being applied at the same time to the vertically deflecting plates, the luminous spot has at any instant a horizontal displacement proportional to the time and a vertical displacement proportional to the instantaneous value of the transient voltage. The trace on the fluorescent screen is thus a graph showing the variation in time of the transient voltage. The scales both of voltage and of time can be fixed by the use of a standard alternating voltage.

We have found convenient for this research the Radio Corporation of America Cathode Ray Oscillograph Type TMV-122-B, an instrument developed for general laboratory utility. It contains in the same case with the oscillograph tube a number of accessory circuits, including a sweep circuit of variable frequency, circuits with amplifier tubes through which the voltages applied to the deflecting plates can be either amplified or attenuated, and circuits for converting power at 110 volts and 60 cycles to the types required in the oscillograph.

Since the potential differences developed by the eel are longitudinal, measurements are conveniently made by removing the eel from the water and laying it in a trough of insulating material ribbed with transverse wires evenly spaced. The skin of the eel is kept in contact with these wires. By means of dial switches, any wire can be connected to any one of the deflecting plates of the oscillograph.

Most of the observations to be described here were made on two eels. Eel I was 92 cm. in length. Its girth was 21 cm. at a distance of 20 cm. from the snout and the same at a distance of 50 cm. from the snout. Eel II was 88 cm. long and had a girth of 18 cm. at a distance of 20 cm. from the snout and a girth of 16.5 cm. at a distance of 50 cm. from the snout.

In discussing most of these observations, the eel, or, rather, any one of its electric organs, can be regarded as some sort of power line, with all the significant variations occurring in one dimension only, that of the length of the eel. The quantity most directly measured with the oscillograph is the potential difference between two points on this line. But potential is not the quantity in terms of which the discharge is most conveniently described. For example, consider a point on the eel's tail, posterior to all the electric organs. The potential of such a point with respect to the eel's head varies in the discharge from zero to a peak negative value and back to zero, though no electromotive force is developed nearer this point than the end of the nearest electric organ. It is more convenient to describe the discharge in terms of some quantity of which the value at any point is wholly determined by the transformations of energy in the immediate neighborhood of that point. Such a quantity is the potential gradient or voltage per unit length along the eel. In the discharge of an electric organ, if no appreciable current is drawn, the potential gradient remains practically zero at any point anterior or posterior to the organ, while it rises to a maximum and falls again to zero at any point along the electric organ. If at any instant the potential gradient is uniform over the distance between two given points, the potential difference between them at this instant is simply the product of the potential gradient by the distance. More generally, the potential difference between two points is the integral from one point to the other of the potential gradient.

One of the first questions to present itself is whether the potential gradient varies synchronously at all points along the discharging electric organ, so that the potential gradient at any given point maintains during the discharge a fixed ratio to the potential gradient at every other point, or whether on the contrary there is a time lag in the rise and fall of the potential gradient between one point and another. This question is easily decided by the oscillograph. One plate of each pair in the oscillograph tube is connected to a point somewhere near the middle of the electric organ. The other plate of the horizontally deflecting pair is connected near the anterior end of the electric organ and the other plate of the vertically deflecting pair is connected near the posterior end. The organ is thus divided into an anterior and a posterior segment in such a way that the potential difference over the anterior segment produces a horizontal deflection of the luminous spot on the fluorescent screen of the oscillograph and the potential difference over the posterior segment produces a vertical deflection. If the potential gradient varies synchronously at all points, then the potential difference over the anterior segment will maintain a constant ratio to the potential difference over the posterior segment. The horizontal deflection will therefore be in a constant ratio to the vertical deflection, and the oscillographic trace will be a straight line. If, on the contrary, there is a time lag between the variations of potential gradient at different points along the electric organ, then the path traced by the luminous spot will have a changing slope as the ratio of the potential differences over the two segments changes, and the trace will be a loop of some kind.

In Pl. I, Figs. 1 and 2, are shown oscillographic traces photographed during the discharge of Eel II when the horizontally deflecting plates were joined to the extremities of an anterior segment between points at 15 and 35 cm. from the snout and the vertically deflecting plates were joined to the extremities of a posterior segment between points at 35 and 70 cm. from the snout. The traces of several discharges appear in each picture because the time of exposure was much greater than the time of one discharge. The traces clearly show that the phase of the discharge differs between the anterior and posterior segments. The sense of the difference is, however, not indicated. Since there is nothing to show whether the luminous spot traversed the loop clockwise or counter-clockwise, it is impossible to

tell from the pictures whether the potential difference over the anterior segment leads or lags behind the potential difference over the posterior segment.

Another observation was made to decide this question. The sweep circuit was connected to the horizontally deflecting plates, the timing period being set at 1/60 sec. Two points on the skin of Eel II, 20 and 70 cm. from its snout, were connected to one of the vertically deflecting plates, and two intermediate points, 25 and 50 cm. from the snout, were connected to the other vertically deflecting plate. Thus, there were connected in parallel between the vertically deflecting plates two segments, one extending between the points at 20 and 25 cm. from the snout, the other extending between the points at 50 and 70 cm. from the snout. Since the extreme points of the two segments were connected to one plate and the intermediate points to the other, potential differences in the two segments produced opposing deflections of the luminous spot. The segments were chosen far apart in order to provide the greatest possible time lag. The connections made established two short circuits in the electric organ, but auxiliary observations showed that a short circuit of one part of the electric organ does not drastically change the discharge in another part.

Pl. I, Fig. 3, shows an oscillographic trace photographed with these connections. Because the time of exposure was much greater than the timing period of the sweep circuit, several discharges appear in confused superposition on the right of the picture. But two discharges are shown distinctly on the left. The potential difference developed in the anterior segment caused a deflection downward, that in the posterior segment a deflection upward, and the progression of time was toward the right. Hence, it is evident that the discharge begins in an anterior part and progresses toward the posterior.

From Pl. I, Fig. 1, it is clear that successive discharges are sometimes very different from one another. Traces of the sort shown in this picture were, however, not very frequent. The more regular pattern of Pl. I, Fig. 2, was more often obtained. It appears to be typical of the more intense discharge of the two reported by Eilenfeld. We shall call this the major discharge and certain evidence will be given which makes it probable that this discharge is generated in the large electric organs of the eel.

From inspection of Pl. I, Fig. 2, certain inferences can be made concerning the propagation of the discharge. We have to consider not only the variation in time of the potential gradient at a given point on the electric organ, but also the variation from point to point along the organ of the potential gradient at any given instant. These two variations can be regarded as constituting together a surge or pulse of electric gradient running along the electric organ from anterior to posterior. Ahead of this pulse and behind it the potential gradient is zero. As the front of the pulse advances into any given segment of the electric organ, it builds up potential difference over that segment. As the rear of the pulse progresses out of a given segment, the potential difference over that segment falls. It is convenient for discussion to divide the pulse into three sections, a rising slope, a plateau, and a falling slope. The division is arbitrary and the sections must not be expected to show sharp boundaries. At any instant, the rising slope comprises that segment of the electric organ in which the potential gradient is rising, the plateau comprises the segment in which the potential gradient is changing slowly enough to be regarded as constant, and the falling slope comprises the segment in which the potential gradient is falling. The segment of the organ included in any one section of the pulse is, of course, continuously changing as the pulse progresses down the organ.

In Pl. I, Fig. 2, the lower horizontal side represents the building up of potential difference over the anterior segment of the organ, the segment extending between points at 15 and 35 cm. from the snout. As the rising

slope of the pulse reaches the point at 35 cm., the potential difference starts to rise in the posterior segment, and the trace accordingly starts to bend toward the vertical. When the rising slope has entirely passed the point at 35 cm., the whole anterior segment is occupied by the plateau of the pulse. The potential gradient is no longer changing in any part of the anterior segment and the voltage over this segment is for the time constant. It will be noticed that the lower side of the loop is horizontal for most of its length; the voltage in the posterior segment does not rise appreciably until the voltage in the anterior segment has attained almost its peak value. This means that the rising slope of the pulse is short in comparison with the anterior segment, so that when the rising slope reaches the 35 cm. point, the anterior segment is already largely covered by the plateau.

The nearly vertical right side of the loop shows the voltage rising in the posterior segment while it is maintained practically constant in the anterior segment. The voltage in the anterior segment does not fall appreciably until the voltage in the posterior segment has almost reached its peak, as is shown by the sharp upper right corner of the loop and the horizontal upper side. The plateau of the pulse is thus almost long enough to cover the whole length of both segments, a distance of 55 cm.

The upper side of the loop shows the voltage falling in the anterior segment while it is maintained practically constant in the posterior segment. At the sharp upper right corner, the leading point of the falling slope of the pulse is just entering the anterior segment at 15 cm. from the snout. At the rounded upper left corner, the leading point of the falling slope is just entering the posterior segment at 35 cm. from the snout, having traversed the anterior segment. During this process the voltage in the anterior segment has fallen to a small fraction of its peak. Therefore, most of the falling slope must be comprised in the length of the anterior segment, a distance of 20 cm.

The pulse of potential gradient in the major discharge has thus a short rising slope, probably less than 10 cm. long, a long plateau, about 50 cm. long, and a fairly steep falling slope, not much more than 20 cm. long. The whole pulse would appear to be longer than the large electric organ. This simply means that there is no instant in which the whole pulse is developed in the organ, the front of the pulse running off the posterior end of the organ before the falling slope is entirely developed at the anterior end. These dimensions of the pulse are, of course, very roughly estimated. The form of the pulse appears to vary not only with the size of the eel, but also between eels of approximately the same size. In oscillographic traces obtained with Eel I in the same way as those of Pl. I, Fig. 2, were obtained with Eel II, the loops are much narrower and less rectangular than those shown in Pl. I, Fig. 2.

It should also be made clear that the plateau is a region in which the potential gradient at any given point is constant in time, but not a region in which the potential gradient at a given instant is uniform over all points. If the potential gradient had a uniform value all along the plateau, the peak voltage over any segment of the electric organ shorter than the plateau would be the product of this uniform value by the length of the segment. The peak voltages over two such segments would thus be in the same ratio as the length of the segments. That this is not the case is shown by the shape of the loop in Pl. I, Fig. 2. The peak voltage over the anterior segment, represented by the horizontal distance across the loop, is considerably greater than the peak voltage over the posterior segment, represented by the vertical distance across the loop, although the length of the anterior segment is 20 cm. and the length of the posterior segment is 35 cm.

The loop of Pl. I, Fig. 2, carries, of course, no time calibration and, therefore, gives no indication of the speed at which the pulse travels. But

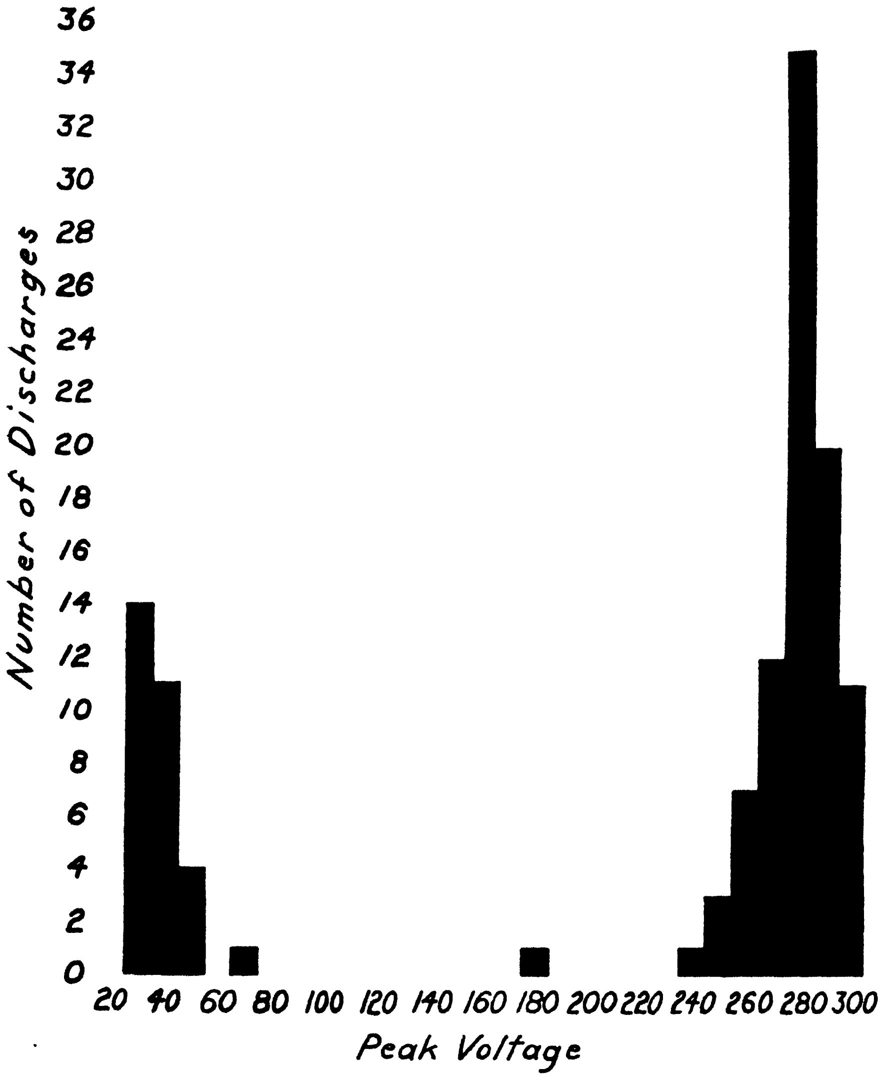
from Pl. I, Fig. 3, in which the heavy base line denotes 1/60 sec., it appears that the whole discharge in both segments takes about .003 sec. This is the time between the instant at which the front of the pulse reaches the point 15 cm. from the snout and the instant at which the rear of the pulse reaches the point 70 cm. from the snout. Hence, it is the time required for the pulse to traverse a distance of 55 cm. in addition to the whole length of the pulse itself, which is perhaps 80 cm. or more. The pulse thus appears to travel about 1.5 meters in .003 sec., and to have a speed therefore of the order of 500 meters per second. Other estimates, to be given later in this paper, show the same order of magnitude.

Several series of observations were made in order to identify more precisely the different types of discharge by their peak voltages as developed between different points along the eel and by the sequence in which they occur after excitation of the eel. The sequence could be studied only by having the timing period of the oscillograph long enough to show a number of discharges during one period. The period chosen was 1/20 sec. The fluorescent screen was photographed with a motion picture camera making 16 exposures per second. The end of the exposure cut off sharply the luminous trace on the fluorescent screen. The end being thus marked, and the time of exposure being less than the timing period of the sweep circuit, the order in time of two or more discharges occuring during one exposure was evident. The beginning of the luminous streak, on the other hand, was gradual because of the afterglow on the fluorescent screen, which carried over to each exposure a faint record of the motion of the luminous spot just preceding the exposure. In the most fortunate of these observations, this afterglow persisted over the whole interval between two successive exposures and so gave a continuous record. In other observations, there was a brief interruption of the record for one or two hundredths of a second between each two successive exposures.

With different connections of the oscillograph to Eel I, the peak voltages of more than 800 discharges were measured to the nearest multiple of 10 volts. Text-fig. 1 shows the distribution with respect to peak voltage observed when one of the deflecting plates of the oscillograph was connected to the snout of the eel and the other was joined to a point 85 cm. from the snout, near the tip of the tail. It is clear that nearly all the discharges observed are grouped around a higher and a lower peak voltage. The discharge of higher peak voltage we have called the major discharge, and that of lower peak voltage we shall call the minor discharge. Besides the discharges which can be classified in one or the other of these types, there appear certain others, in number about 5 per cent. of the total recorded, which could not be so classified. These are especially numerous in one series of observations in which one vertically deflecting plate of the oscillograph was connected to the snout of the eel and the other to a point 55 cm. from the snout. The distribution with respect to peak voltage of the discharges recorded with these connections is shown in Text-fig. 2. The discharges with peak voltages between those of the major and minor types are so variable in voltage that it is hard to say whether they belong to one type or to several. But tentatively, we shall assume that they belong to a single type, which we shall call intermediate.

The types of discharge are also distinguished by the sequence in which discharges of the several types appear. The discharges occur commonly in trains of three or usually more members. The average interval between two discharges in a train is between .005 and .006 sec., as measured from the start of one to the start of the next. In the longer trains the interval is commonly less between the first members and greater between the last, being sometimes as short as .003 sec. at the beginning of the train and sometimes as great as .015 sec. at the end. For several reasons, the number and types of the discharges in one train are not always clear on the film.

The start or the end of a train is often lost in an unrecorded interval between two exposures. With both contacts near the head the minor discharge does not appear and with both contacts near the tail, the major and minor discharges are too much alike to be distinguished. However, a number of unambiguous traces were found on the film. Two of these are shown in Pl. I, Figs. 4 and 5. In Pl. I, Fig. 4, a minor discharge is followed by a number of majors, in this instance, five. This appears to be a characteristic combination of these two types, though the number of majors following the minor is found to vary from two to five, two being rare and more than five not being observed. (A sixth major could, however, be lost in an unrecorded interval between two exposures.) Pl. I, Fig. 5, shows a minor,

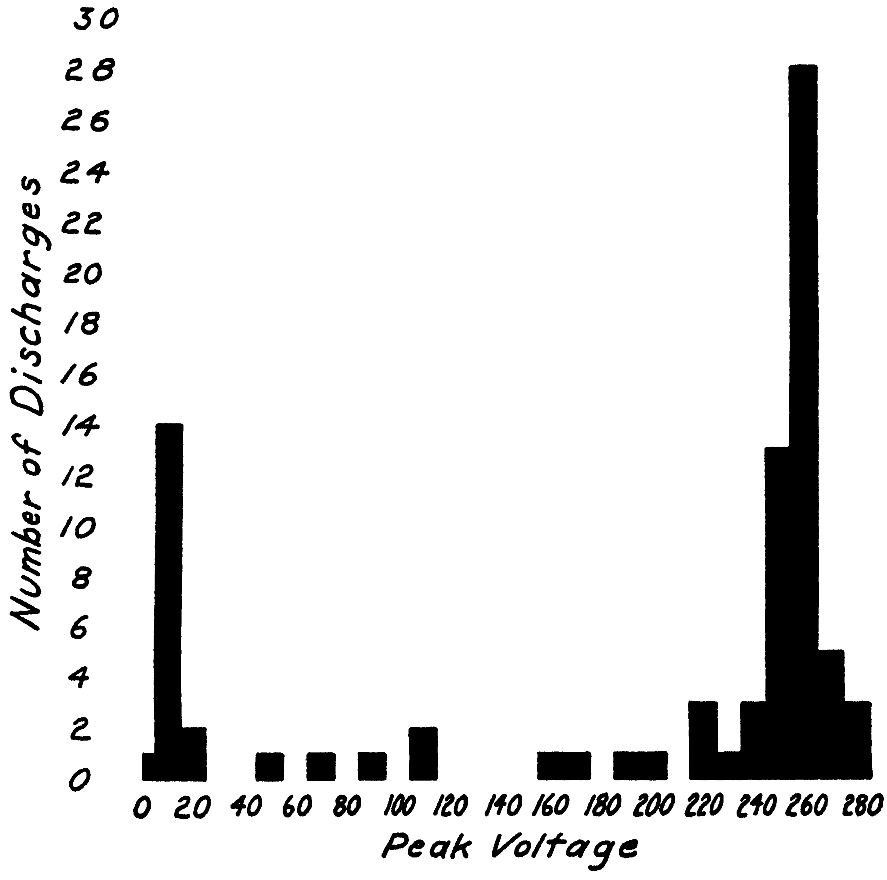


Text-figure 1.
Numbers of discharges with various peak voltages. Eel I. Contacts at snout and 85 cm. from snout.

quite small, followed by an intermediate and three majors. The marked difference in form between the intermediate and major discharges is to be noted. It is shown with a larger time scale in Pl. I, Fig. 11. It seems characteristic of the intermediate discharge that it occurs between a minor and a train of majors.

Certain apparent exceptions to these two kinds of train were recorded. There are two nearly certain instances of a single minor not followed by a major or an intermediate. Other examples of this have frequently been noticed visually. There is one instance, not quite certain, of a single major. There are a few cases in which the second discharge of a train, as well as the first, may be a minor, but it seems likely that it is an intermediate of low peak voltage. As against these instances there are some hundred and fifty cases in which a minor discharge is followed by a major or an intermediate discharge, the number of discharges afterward being sometimes determinable on the film and sometimes not.

Because of the quantity of film required for observations of this kind and the considerable labor involved in measuring so many peak voltages and time intervals, so extensive a series of discharges was recorded and studied only with Eel I. A fairly extensive series was recorded also with



Text-figure 2.

Numbers of discharges with various peak voltages. Eel I. Contacts at snout and 55 cm. from snout.

an eel 38 cm. long, and an inspection of the film showed some of the regularities just described.

Tables I and II show the distribution with respect to peak voltage of all the discharges of Eel I measured in this way. In the observations recorded in Table I, one vertically deflecting plate was kept connected to the snout of the eel and the other was connected in turn to points 5 cm. along the eel. In the observations recorded in Table II, one contact was fixed 85 cm. from the snout while the position of the other was varied in steps.

From these tables, the mean peak voltage of the major discharge was found for each position of the contacts. The values are shown in Curves A and B of Text-fig. 3. For each curve the horizontal scale shows the distance of the variable contact from the snout. In curve A, plotted from Table I, the fixed contact is at the snout, and the peak voltage of the major discharge, shown on the vertical scale, increases as the variable contact is moved toward the tail. In curve B, plotted from Table II, the fixed contact is near the tip of the tail, 85 cm. from the snout, and the peak voltage de-

TABLE I.

Number of discharges with different peak voltages with one contact fixed at the snout end and the other at various distances from it along the body of the eel. Numbers of minor discharges are marked (*). Numbers of intermediate discharges are marked (#). All other numbers are of major discharges.

Peak Voltages from Snout to Variable Contact	Position of Variable Contact, Centimeters from Snout														
	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
295–305													1	3	11
285–295											6	5	7	11	20
275–285						1	1		3	18	6	7	15	11	30
265–275						1	6	2	5	24	22	9	14	2	7
255–265						1	10	3	28	15	2	2	3		5
245–255						3	24	5	13	8	3	1			
235–245						10	1	1	3	2				1	
225–235					3	13	1		1						
215–225					3	7		1	3						
205–215					12			1							
195–205					5	2			1				1		
185–195					1				1#						
175–185				5	1							1#			
165–175				16					1#						
155–165				1					1#						
145–155															
135–145															
125–135			6												
115–125			2												
105–115									2#						
95–105															
85– 95		1							1#						
75– 85		14					1#								
65– 75									1#						1#
55– 65					1#										
45– 55					1#				1#	1#	1#		2*		4*
35– 45	5	1, 1#											4*	2*	10*
25– 35	10	1#	1#		1#	1#	1#	1#		4*	2*, 1#	3*	8*	8*	7*
15– 25	1#	1#			1#		2*	1#	2*	14*	6*	3*		1	
5– 15	1#	3#	3#	3#	2*	7*	8*	1*	14*	6*	2*				
0– 5		2#		6*	7*	6*	1*	3*	1*						

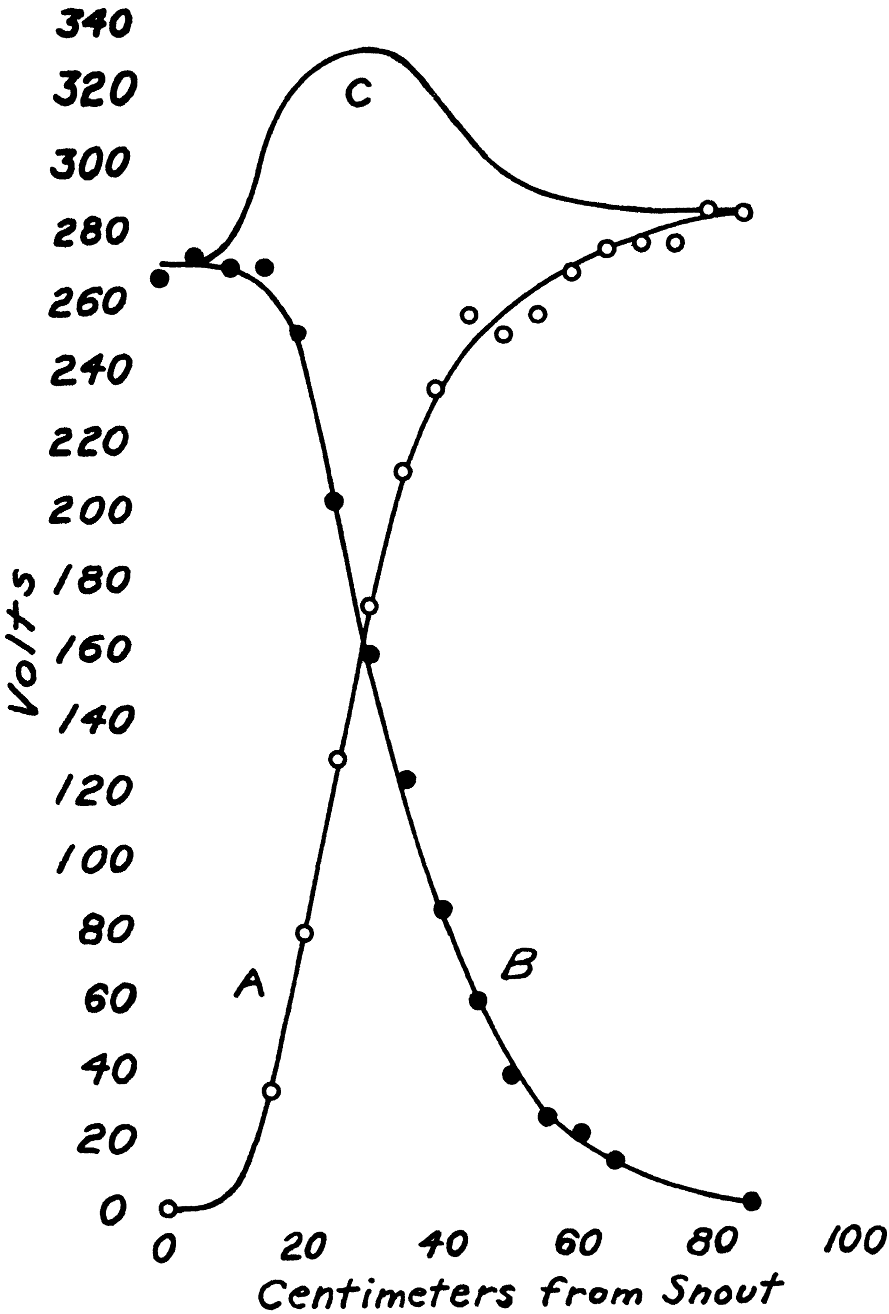
creases as the variable contact is moved from the snout toward the tail. Curve C is obtained by adding the vertical coördinates of curves A and B. That is, curve C shows for any given point along the eel the sum of the peak voltages from the snout to that point and from that point to the tail. If the peak voltage were attained at the same instant at every point along the eel, this sum would be simply the peak voltage between the snout and tail of the eel, and curve C would be a horizontal straight line. Its rise around the middle part of the eel, in the region of greatest potential gradient, is evidence, additional to that shown in Pl. I, Figs. 1-3, that the discharge is not synchronous along the electric organ, but that there is, on the contrary, a time lag between points longitudinally separated. This effect is also noticeable, though not marked, in the mean peak voltages observed in the major discharge of a smaller eel as recorded in our previous paper, but we had not recognized its significance at the time that paper was written.

From Text-fig. 3 it appears that in the major discharge electromotive force is generated over a length of Eel I extending between points at about 12 and 75 cm. from the snout. These points are near the ends of the large electric organs, and it seems reasonable to suppose that the major discharge

TABLE II.

Numbers of discharges with different peak voltages with one contact fixed 85 cm. from the snout and the other at various positions along the body of the eel. Discharges of different types are distinguished as in Table I.

Peak Voltages from Variable Contact to Tail	Position of Variable Contact, Centimeters from Snout													
	0	5	10	15	20	25	30	35	40	45	50	55	60	65
295–305			1											
285–295			1	1										
275–285	5	2	1	3										
265–275	5	2	1	1										
255–265	2	1	1	1	6	1								
245–255	3		3	1	10									
235–245	1			1	6									
225–235			1#											
215–225						1								
205–215														
195–205						2								
185–195						1								
175–185	1#													
165–175							2							
155–165							4							
145–155							2							
135–145							1							
125–135								1						
115–125								3						
105–115														
95–105								1#						
85– 95									5					
75– 85									6					
65– 75														
55– 65										4				
45– 55										1				
35– 45	1*				5*			1*			7			
25– 35	7*	1*	3*	4*	2*	1*	2*	1*	2*		3, 1*	3, 1*		
15– 25											2*, 1#	3	2, 1*	1, 1*
5– 15														5
0– 5														



Text-figure 3.

Mean peak voltages of major discharge between various points along eel. Eel I. A: One contact fixed at snout. B: One contact fixed at 85 cm. from snout. C: Sum of peak voltages of A and B.

originates in these organs, the more so as they are much the largest of the electric organs and most of the electric energy discharged by the eel is released in the major discharges.

The records in Tables I and II of the peak voltages of the minor discharge are not precise enough to enable curves to be drawn like those for the major discharge shown in Text-fig. 3. But from Table I it is clear that with one contact fixed at the snout the peak voltage of the minor discharge is very low until the variable contact is some 40 cm. from the snout. And from Table II it is clear that with one contact fixed at the tail the peak voltage is about the same for all positions of the variable contact nearer the snout than some 40 cm. At 60 cm. from the snout, the peak voltages of the major and minor discharges are about equal. It appears that the electromotive force of the minor discharge is generated in the posterior half of the eel, and most of it in the posterior third. This suggests that the minor discharge originates in the bundles of Sachs. These lie in the posterior half of the eel and, instead of having nearly their maximum cross-section at their anterior end, as the large electric organs have, they increase in cross-section for some distance toward the tail, finding room at the expense of the large organs, which taper off in the same region.

If the intermediate discharge has its special electric organ, as the major and minor discharges appear to have, then it probably originates in Hunter's organs. On the other hand, the fact that the intermediate discharge appears to take the place of a major discharge in the train of discharges, and the further fact that the major discharge next following an intermediate discharge is often of less than mean peak voltage indicate that the intermediate discharge is closely connected with the major discharge and suggest that it may be merely an anomalous form of the major discharge, instead of having a separate origin.

For the study of the variation of voltage in a single discharge, oscillographic traces on a much larger time scale than that of Pl. I, Figs. 4 and 5, are required. We have made a fairly thorough study only of the major discharge, as observed with Eels I and II. The timing period of the sweep circuit was set at 1/240 sec. The vertically deflecting plates of the oscillograph were connected to two points along the eel and the shutter of the camera was held open until the eel was provoked by gentle prodding to discharge. Particular attention was given to the potential differences developed in that part of the eel's length in which the large electric organs are of fairly uniform cross-section, in order to study the discharge without the complication caused by the tapering of the organs. In an eel of the size of these the large electric organs are of fairly uniform cross-section over a length of some 30 cm. starting almost at their anterior end. With each of these eels on open circuit, two series of oscillographic traces were recorded. In one series the fixed contact was 20 cm. from the snout and the variable contact was successively at positions equally spaced over a length of 30 cm. starting at the fixed contact. In the other series, the fixed contact was 50 cm. from the snout and the positions of the variable contact were the same as in the first series. Pl. I, Figs. 6-11, shows some of the traces so obtained with Eel I. Except in Pl. I, Fig. 11, which was reproduced because it shows an example of the intermediate discharge, all the traces shown are of major discharges. Time increases toward the right in all the pictures.

It will be seen at once that there is on each trace a sharp break between a period of rapidly rising voltage and a longer period of nearly steady voltage, and that there is a more gradual transition from the latter period to a period of falling voltage. Viewing the rising branch of the trace more closely, it is seen that the rate of increase of voltage, as measured by the slope of the curve, increases to a maximum at the place of steepest slope and, after holding this value briefly constant, falls quickly to zero at

the break of the curve. The description of a pulse of potential gradient given in the discussion of Plate I accounts, qualitatively at least, for these variations. It will be recalled that the pulse there described had a steep rising slope, a long plateau, and a fairly long falling slope. Consider a segment of the electric organ longer than the rising slope but shorter than the plateau. The segments with which the traces of Pl. I, Figs. 6-11, were obtained are probably all of such a length. As the pulse approaches the anterior end of the segment, the potential difference between the ends of the segment remains zero until the front of the rising slope enters the segment. Then the voltage starts to rise, at first slowly, however, not only because the part rendered active by the pulse is still short but also because the potential gradient near the front of the rising slope is still small. But as the rising slope advances into the segment, the rate of increase of voltage becomes greater, and when the whole rising slope is in the segment, the voltage is rising at maximum speed. This rate is maintained until the front of the rising slope passes the posterior end of the segment. The rate of increase of voltage in the segment then becomes less than the maximum, since some of the potential difference caused by the advance of the pulse is outside the segment. When the whole rising slope has passed out of the segment, leaving the segment entirely covered by the plateau, the potential difference over the segment is constant, since the potential gradient is constant at every point. Then, as the front of the falling slope enters the segment, the voltage begins to fall, but slowly at first, because the region of falling potential gradient is still short. As the pulse advances farther the rate of fall increases. The fall is probably near its steepest when the front of the falling slope reaches the posterior end of the segment and the potential gradient is no longer sustained in any part.

As the pulse of potential gradient runs down the electric organ, all points ahead of the pulse are at the same potential. Consequently, when the front of the pulse has passed the first of a set of points along the organ, but has not yet reached the second, the potential difference between the first and second is the same as between the first and third, and so on. Hence, in a series of traces obtained with a fixed anterior contact and a variable posterior contact, the rising branches of the various traces should all be identical almost to the break. Or, more strictly, since successive discharges do not give exactly the same trace even with both contacts the same, what we should expect is that the traces obtained with different positions of the posterior contact should show no greater differences up to the break than do traces obtained with the same position of the posterior contact. In our observations this appears to be true. If then in such a series of traces the mean time intervals from the start of the discharge to the break be measured for two positions of the variable contact, the difference in these intervals should be the time the pulse takes to travel from one position to the other. Such measurements were made on a large number of traces in the series illustrated by Pl. I, Figs. 6-11. The results are shown by the solid circles of Text-fig. 4, the distances between the fixed and variable contacts being plotted vertically and the time intervals horizontally. The open circles show the corresponding distances and time intervals as measured on the traces obtained with a fixed posterior and a movable anterior contact. The argument in this case is like that in the other except that in this case the break would occur at the same instant for all positions of the anterior electrode, while the start of the discharge would occur earlier the farther the anterior contact was from the posterior.

Even with care only very crude measurements are possible, and the information obtained about the speed of the pulse is only qualitative. A smooth curve drawn to fit as well as possible either the solid or the open circles will have a slope increasing toward the right, and from this it may at first appear that the pulse runs down the electric organ with an ac-

celerated motion. This interpretation is, however, not justified, for the lower solid circles refer to the region just more than 20 cm. from the snout, while the lower open circles refer to the region just less than 50 cm. from the snout, and vice versa for the upper circles. It seems likely that the points below 10 cm. on the vertical scale should be ignored in reckoning the speed of the pulse, since the rising slope of the pulse may itself be somewhere near 10 cm. long. The other points are spread along a roughly indicated slope. The line drawn in the figure has a slope corresponding to a speed of 1,200 meters per second, but this should not be taken as giving

Text-figure 4.

Distances traversed by the potential pulse of major discharge in various intervals of time. Eel I. Black circles: Fixed contact at 20 cm. from snout. Movable contact at distances toward tail from fixed contact as shown on vertical scale. White circles: Fixed contact at 50 cm. from snout. Movable contact at distances toward snout from fixed contact as shown on vertical scale.

more than the general order of magnitude of the speed of the pulse in Eel I.

Pl. II, Figs. 1-5, shows traces obtained with Eel II corresponding to those for Eel I shown in Pl. I, Figs. 6-11. The general character of the discharge appears similar in the two eels, but neither the break in the rising branch nor the flat top of the trace is marked with Eel II as with Eel I. (These features are less marked also with any of the smaller eels we have studied. In the visual observations reported in our previous paper, we did not notice them at all.) Because the break is not so sharp with Eel II as with Eel I, and also because the number of traces photographed is smaller, a figure like Text-fig. 4 made from the traces obtained with Eel II tells even less than Text-fig. 4. The data suggest for the major discharge of Eel II a speed of the general order of 800 meters per second, to be compared with the estimate of 500 meters per second made for the same eel from Pl. I, Figs. 1-3.

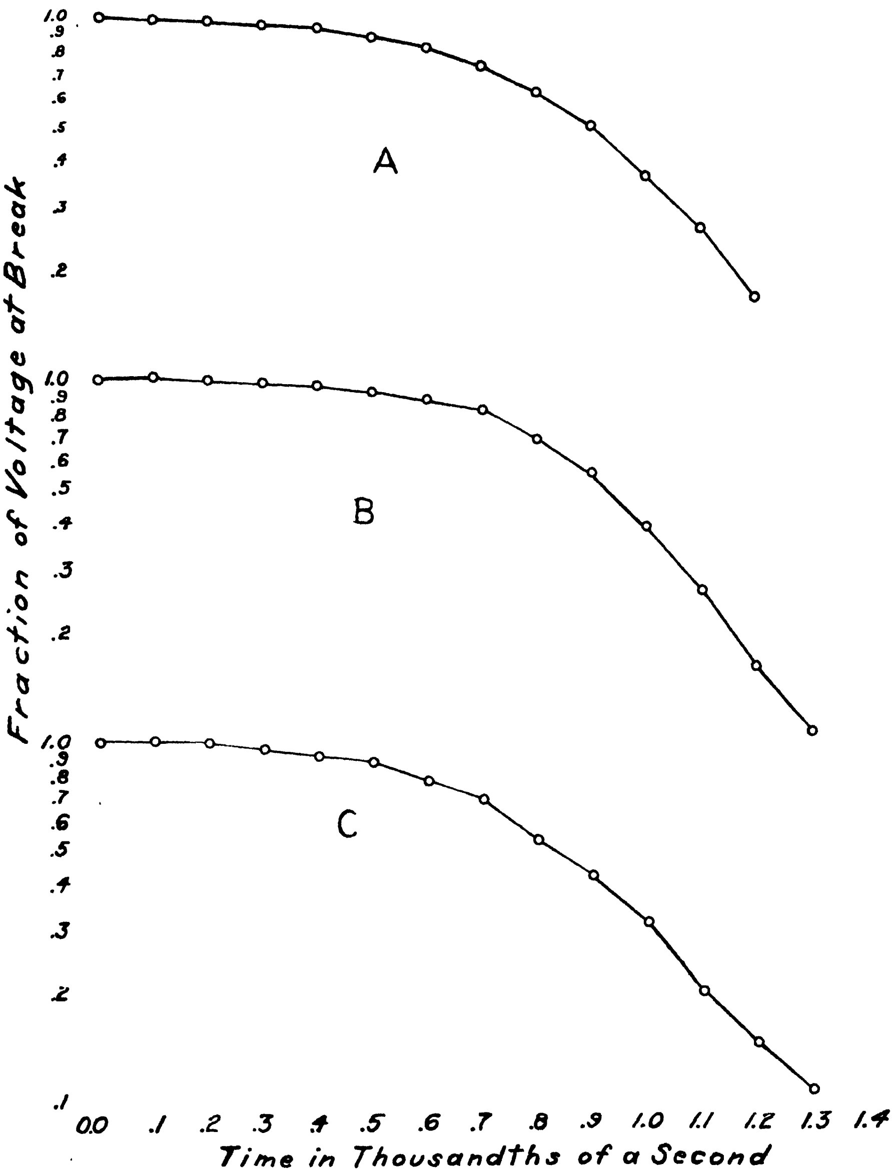
From the break on, different traces obtained with the same eel do not differ greatly except in the vertical scale. This is shown in Text-fig. 5, in which the ratio of the voltage at any instant to the peak voltage is plotted vertically and the time after the break is plotted horizontally from measurements on the traces of three discharges of Eel II. The vertical scale is logarithmic; that is, equal distances represent equal intervals in ratio. Each of the three curves shown ends on the right in an approximately straight falling branch. The scale of voltage being logarithmic, this indicates that the fractional rate of decrease of the voltage is constant; that is, the time required for the voltage to drop by one-half, for example, is the same whether the voltage be high or low. This type of decrease is characteristic of the voltage of an electric capacity discharging through a resistance, and it may be that some such mechanism is operative in the electric organs.

The time interval between the instant at which the rising branch of the trace breaks and the instant at which the fractional rate of decrease becomes constant is very closely the same for one eel whatever the distance between the contacts. The rising branch breaks when the front of the plateau of the pulse reaches the posterior contact. It seems likely that the fractional rate of decrease of potential gradient becomes constant at any one point when the rear end of the plateau passes that point, and consequently the fractional rate of decrease of potential difference between two contacts becomes constant when the rear end of the plateau passes the posterior contact. If this is true, the interval noted is the time taken for the entire plateau of the pulse to pass a given point on the electric organ. From Text-fig. 5 this interval is about .001 sec. for Eel II. The length of the plateau was reckoned at about 50 cm. in the discussion of Pl. I, Figs. 1-3, and the speed of the pulse would thus be 500 meters per second. This is the same as the first estimate made for this eel.

It may be worth while to remark that the plateau of the pulse not only prolongs the discharge but also increases the peak voltage developed over the whole electric organ. High voltages over the whole organ are developed only by the addition of the voltages in different segments, and the highest voltage that can be developed in the whole organ is only the voltage that can be developed in whatever length of the organ is active at one time. If the length of the organ were increased without an increase in the length of the plateau, the discharge would last longer without attaining a much higher peak voltage, and if the length of the plateau were decreased without a change in the length of the organ, the discharge would last as long as before but would not attain so high a peak voltage.

In order to get some notion of the power of the discharge, a variable resistance was connected between points at 20 and 70 cm. from the snout of Eel I, and the vertically deflecting plates of the oscillograph were con-

nected to measure the voltage developed across this resistance. From the values of the voltage and the resistance, the power externally delivered in the discharge could be calculated. The circles in Text-fig. 6 show the power at the peak of the discharge found with different observed values of the

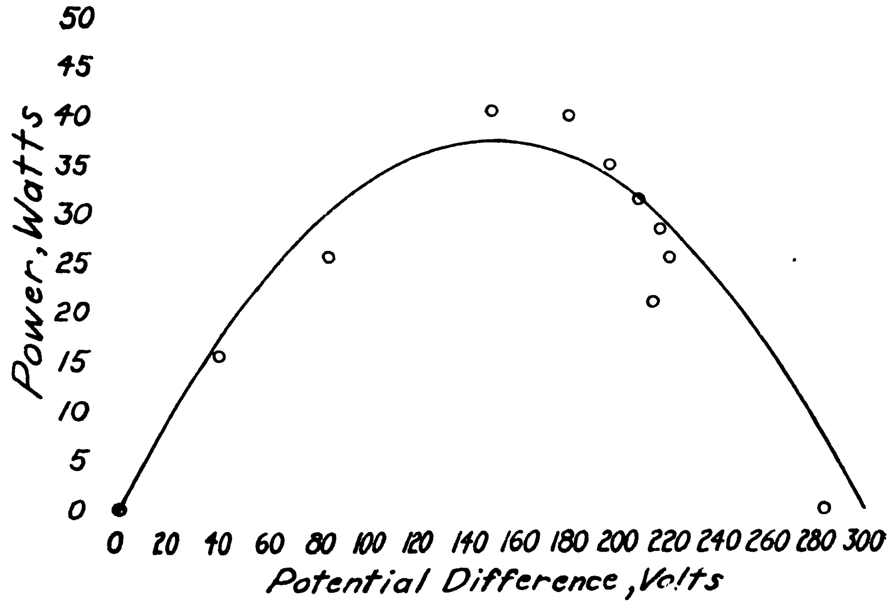


Text-figure 5.

Decay of potential difference in major discharge. Eel II. Horizontal scale shows time measured from break in potential difference. Vertical scale shows potential difference plotted logarithmically, potential difference at break being taken as unity. A: Contacts at 20 and 40 cm. from snout. B: Contacts at 30 and 50 cm. from snout. C: Contacts at 20 and 50 cm. from snout.

voltage. The maximum external power is about 40 watts and is found at a voltage about half the open-circuit voltage. Since an electromotive force operating through a fixed internal and a variable external resistance also delivers maximum power externally at half the open-circuit voltage, there has been drawn for comparison with the observations the power-voltage curve for an electromotive force of 300 volts and an internal resistance of 600 ohms. The same eel in a tank filled with the water to which it is accustomed develops between the same points of contact a potential difference of 150 volts. The water, being in contact with the whole skin of the eel, is of course not electrically equivalent to a resistance connected between two points. Neither is there any reason to expect that the electric organ can be represented even approximately by an electromotive force and an internal resistance.

Nevertheless, although the argument can not be made at all precise, it seems likely that the evolution of the eel has brought about such a series-parallel connection of the electromotive elements as to approach the condition for maximum external power. In this connection, a comparison of the different species of electric fishes is suggestive. The fresh-water species, the Electric Eel, the Electric Mormyridae, and the Electric Catfish, all have longitudinal electric polarity. The first two are long in proportion to their width and thus well adapted in shape to the development of a prevailingly series connection to build up a high electromotive force against the high external resistance of fresh water. The electric organ of the Electric Catfish forms a sheath under its skin and is also of small cross-section in comparison with its length. Both the Electric Ray and the Star-gazer, on the other hand, have a polarity between their upper and lower surfaces and their shape is suited with this polarity to a prevailingly parallel connection for a low internal resistance against the low resistence of the salt water in which they live. Those members of the ostracoderms, fossil fish-like



Text-figure 6.

Peak potential difference and power developed by major discharge in various resistances connected between points 20 and 70 cm. from snout. Eel I.

chordates, which Stensiö believes to be electric and which were supposedly marine in habitat, also seem to have had a polarity between the upper and lower surfaces.[2]

The maximum energy delivered externally in one discharge was computed from the same traces as were used to find the power. It was found to be between .03 and .04 joule. More than a hundred discharges would be required to deliver externally one gram-calorie. The energy of a discharge under water is doubtless different from this but is probably of the same order of magnitude.

The average electric power which the electric organ can continue to deliver over any considerable length of time does not appear to be greater than the mechanical power developed by a muscle of the same size. The speed with which peak power is attained is doubtless much greater in electric than in muscular tissue. The electric discharge has, it seems, no retarding factor comparable to mechanical inertia in muscular activity.

The rate at which the power attains its peak value is determined in part by the speed with which the pulse of potential gradient runs down the electric organ. This speed, according to our estimates, (from 500-1,000 meters per second), is so much higher than the reported speeds of propagation of nerve impulses as to raise some doubt whether or not the discharge is propagated or only initiated by a nervous impulse. There is another observation which appears hard to reconcile with the supposition of a nervous propagation. Impulses along nerves commonly show dispersion; the impulse is divided among a number of parallel nerve fibres along which it travels at different speeds. Thus the impulse spreads as its swifter components draw away from the slower. Nothing of this sort is observed in the propagation of the discharge of the electric eel. The break in the rising branch of the oscillographic trace is just as sharp at some distance down the electric organ as it is at the anterior end, and the interval from the break to the start of uniform fractional decrease is no longer in a posterior than in an anterior segment. Although these considerations are probably not final against the hypothesis of nervous propagation, they at least suggest that an alternative hypothesis should be sought.

In the discharge of the electric organ a very large number of cellular electromotive forces must act in series. It can hardly be that the cells are permanently connected in series and are kept steadily charged, for the tissue of the eel can not be expected to provide insulation against such a voltage. It may be that they are permanently connected in series but their electromotive forces are generated only at the commencement of the discharge. Or it may be that they are fully charged in the inactive state of the organ but are connected in series only during the discharge. On the latter assumption, which at present seems preferable, the charging process might be an electrochemical process of the same kind as occurs in ordinary tissue. The connection in series might be made by a breakdown in insulation between cells. If this be true, the action of the electric tissue would resemble that of the impulse generator recently developed for the production of high voltage. But any such speculation as this requires testing by further experiments.

SUMMARY.

Voltages and speeds of propagation of the electrical impulse along the body of the Electric Eel have been measured. These indicate that an anterior point on the body of the eel is always positive to a posterior point.

2 The work of Sanderson and others on *Raia clavata*, etc., does not seem to fit into this theory. They report a spindle-shaped organ, weakly electric, situated in the tail. Since the order of voltage reported, (0.5 volts per centimeter of length), is what might be expected, according to the hypothesis, in a marine animal, we are willing to advance it as a basis for further, more conclusive, investigations of the discharges of the Skates.

Peak voltages of the order of 300 and peak wattage of the order of 40 are indicated as maximum for eels exceeding 50 cm. long.

The velocity of the pulse along the body of the eel is between 500 and 1,000 meters per second.

Two types of discharge are definitely identified and a third tentatively identified.

The electrical discharges commonly occur in trains of one minor member followed by from three to six major members separated in time by an average of .005 seconds.

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Note: Additional references, particularly to the torpedo, may be found in Dean. 1916-1923, vol. III [Index volume] under Electrical Fishes (pp. 406-408).

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. Phase difference of discharge in anterior and posterior segments. Eel II. Horizontal deflection caused by segment from 15 to 35 cm. from snout. Vertical deflection caused by segment from 35 to 70 cm. from snout.

Fig. 2. Same connections as in Fig. 1.

Fig. 3. Sense of propagation of pulse. Eel II. Horizontal deflection of timing circuit, period 1/60 sec., time increasing to right. Vertical deflection downward by segment from 20 to 25 cm. from snout. Vertical deflection upward by segment from 50 to 70 cm. from snout.

Fig. 4. Train of 1 minor and 5 major discharges. Eel I. Timing period 1/20 sec.

Fig. 5. Train of 1 minor, 1 intermediate, and 3 major discharges. Eel I. Timing period 1/20 sec.

Major discharges. Eel I. Timing period 1/240 *sec.*

Fig. 6. Contacts at 20 and 30 cm.
Fig. 7. Contacts at 20 and 40 cm.
Fig. 8. Contacts at 20 and 50 cm.
Fig. 9. Contacts at 30 and 50 cm.
Fig. 10. Contacts at 40 and 50 cm.
Fig. 11. Intermediate discharge shown at center of trace. Note initial spur and round top.

PLATE II.

Major discharges. Eel II.

Figs. 1-5. Contacts and timing period same as in Pl. I, Figs. 6-10.

Major discharges under various loads. Eel I. Contacts at 20 *and* 70 *cm. from snout. Timing period* 1/240 *sec.*

Fig. 6. Open circuit.
Fig. 7. 1,950 ohms.
Fig. 8. 820 ohms.
Fig. 9. 280 ohms.

FIG. 1.

FIG. 2.

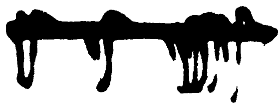


FIG. 3.

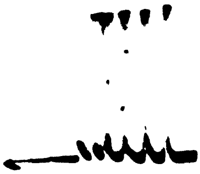


FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG 8.

FIG. 9

FIG. 10.

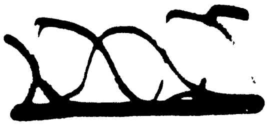


FIG. 11.

THE ELECTRIC DISCHARGE OF THE ELECTRIC EEL, ELECTROPHORUS ELECTRICUS (LINNAEUS).

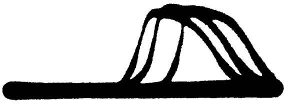


FIG. 1.

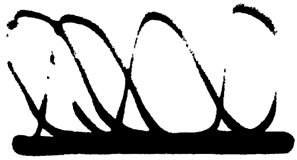


FIG. 2.

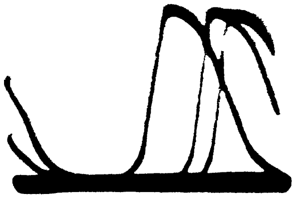


FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

THE ELECTRIC DISCHARGE OF THE ELECTRIC EEL,
ELECTROPHORUS ELECTRICUS (LINNAEUS)

2.

The Templeton Crocker Expedition. II. Introduction, Itinerary, List of Stations, Nets and Dredges.[1]

WILLIAM BEEBE
Department of Tropical Research,
New York Zoological Society.

(Text-figures 1-8).

CONTENTS.

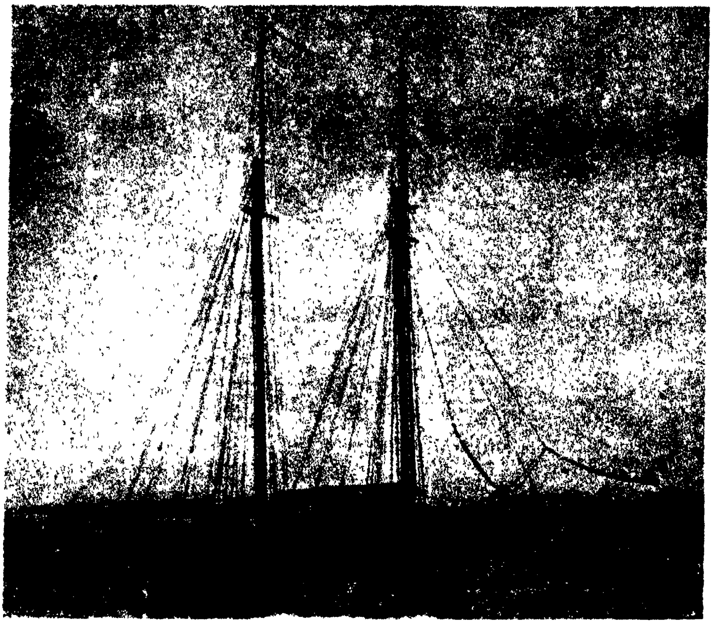
INTRODUCTION.

The Twenty-fourth Expedition of the Department of Tropical Research was the result of an invitation from Mr. Templeton Crocker to accompany him on board his yacht *Zaca* on a trip to the Gulf of California. The Zoological Society is in Mr. Crocker's debt for the opportunities that he gave us to study the animal life of little-known places and for allowing us to concentrate our trawling and dredging activities on a few, carefully-chosen localities. Not only must Mr. Crocker be given full credit for the inception and carrying out of the expedition and for the constant care that he took to see that every wish of ours was provided for, but especial thanks are due to him for his active part in capturing, sorting, labelling and preserving specimens, thousands of which passed through his hands.

Four of the staff of the Department of Tropical Research were members of the expedition: Dr. William Beebe, Director; Mr. John Tee-Van, General Associate; Miss Jocelyn Crane, Technical Associate, and Mr. George Swanson, Artist. Mr. Toshio Asaeda, Mr. Crocker's artist, photographer and taxidermist, will always be remembered for his tireless energy and the able accomplishment of the many tasks that he set for himself. Of the efficient and carefully trained crew of the *Zaca* the following deserve special mention: Captain Alfred Pedersen, for his excellent handling of the ship and of the new dredging machinery and apparatus, First Mate John Ozanne, and the two Samoans, Pemasu Utu and Frank Taiga, both of whom demonstrated amazing skill in the capture of sea and shore life.

The *Zaca* (Text-fig. 1) is a Diesel schooner, 118 feet over all, with a gross tonnage of 84. She is supplied with all of the usual apparatus for capturing fish and animal life, such as seines, nets, submerged lights, etc.,

[1] Contribution No. 520, Department of Tropical Research, New York Zoological Society. This paper should have been No. I of the Templeton Crocker series, but unforeseen circumstances of publication shifted its position. No. I has the following title: The Templeton Crocker Expedition. I. Six New Brachyuran Crabs from the Gulf of California, by Steve A. Glassell, and was published in *Zoologica*, XXI, No. 17, pp. 213-218.



Text-figure 1.
The *Zaca.*

Text-figure 2.
Bow-pulpit and boom-walk of the *Zaca.*
Text-figure 2 from photograph by Toshio Asaeda. Text-figure 1 and 3 to 8 by John Tee-Van.

in addition to which Mr. Crocker provided, expressly for this expedition, a gasoline-engined winch and a 7,500-foot length of ¼-inch diameter steel cable. With this apparatus we were able to trawl with silk plankton nets to a maximum depth of 600 fathoms and to dredge on the bottom with deep-sea dredges. Two newly-built and constantly used features of the vessel were the bow-pulpit placed at the tip of the bowsprit and the boom-walk on the starboard side of the ship (Text-fig. 2).

ITINERARY.

The route of the expedition is shown on the map in Text-fig. 3 and details of positions and depths of dredges at stations where large numbers of dredgings were made, are shown in Text-figs. 4 to 8 inclusive. The dates at the various localities, all in 1936, are as follows:[2] San Diego, March 19; Catalina Island, March 20, 21; San Diego, March 22 to 25; Cedros Island, March 27; Turtle Bay, March 27; Magdalena Bay, March 29; Cape San Lucas, March 30 to April 3; Gorda Banks, April 3; Arena Bank, April 4; Ceralbo Island, April 4; Espiritu Santo Island, April 4; Guaymas, April 6 to 8; Santa Inez Bay, April 9 to 17; Arena Bank, April 19 to 21; Gorda Banks, April 21 to 23; Cape San Lucas, April 23 to 26; Mazatlan, April 27 to 28; Arena Bank, April 30 to May 2; Gorda Banks, May 2 and 3; Cape San Lucas, May 3 to 7; Clarion Island, May 10 to 16; Alijos Rocks, May 19; Cedros Island, May 22; San Diego, May 25.

This list of localities seems rather long, but many of the names are duplicated, Cape San Lucas and Arena Bank, for instance, appearing three times.

Analysis of the time spent by the expedition in various phases of work illustrates the Department's method of concentrating its researches on a few, carefully-chosen localities. Thus 29 of the 61 days (48%) that the expedition was away from San Diego, were spent in sailing or concerned with oceanographic stations, working with plankton nets and submerged lights. During the remaining 32 days we worked littoral localities, mostly within the 100-fathom line. 95 per cent. of these 32 days were divided among three stations as follows: Cape San Lucas and adjacent banks (Gorda Banks, Arena Bank) 17 days (52%); Santa Inez Bay, 7½ days (24%); Clarion Island, 6 days (19%).

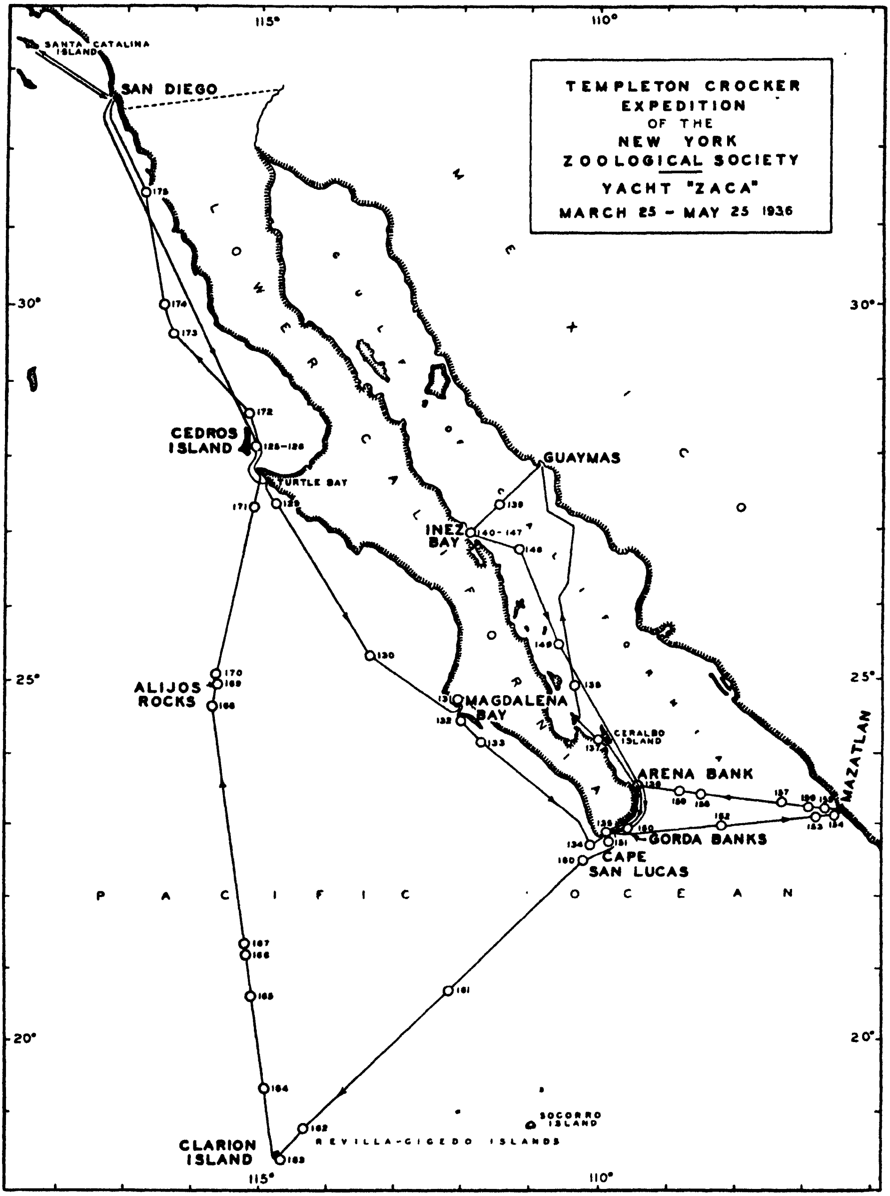
LIST OF STATIONS, NETS AND DREDGES.

In the following tables most of the facts are self-evident and the abbreviations are explained in the following sentences. The station numbers refer to the continuously numbered series of oceanographic stations of the Department of Tropical Research. In the second column the letter "D" refers to dredges and the letter "T" to tow-nets, so that for the sake of brevity a net may be referred to as "126 D-12," indicating the twelfth dredge at Station 126.

In the third column the 2-foot and 4-foot dredges were of the Blake type with mouths of the width stated. The bags of these dredges were of 2-inch and 1-inch stretched mesh, the majority being of the latter size. With the exception of dredge 125 D-1, all of the 2-foot dredge hauls were made from the *Zaca's* tenders. Dredge 125 D-1 and all of the 4-foot dredge hauls were handled from the deck of the yacht, using the ¼-inch steel cable previously mentioned.

The tow-nets of one-half metre and one metre diameter were of standard Michael Sars' type, with 2XX silk bolting cloth posteriorly and OXX bolting cloth anteriorly, the mouth of the net having a collar of shrimp

[2] This list includes only the shore stations and fueling localities. For details as to dates, etc., of the oceanographic stations see the List of Stations, Nets and Dredges.



Text-figure 3.
Route of the Templeton Crocker Expedition. The circles with attached numbers represent the positions of the dredging and oceanographic stations.

netting. The foot nets were diatom nets one foot in diameter and made of No. 20 silk bolting cloth.

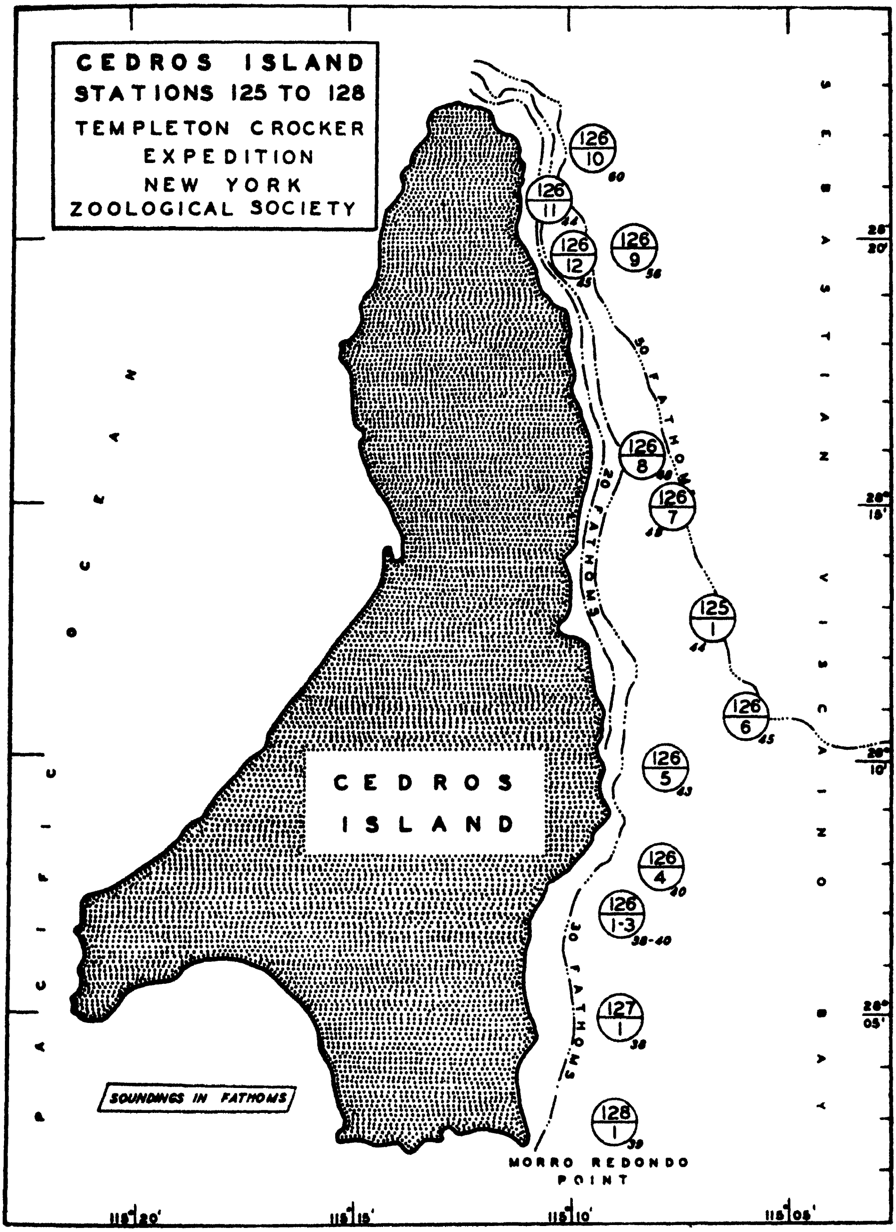
Light, when used in the third column, refers to night stations where submerged electric lights were employed and the captures of animals were made principally with dip nets.

STATION LISTS AND DATA.

Station No.	Net No.	Type of Net	Depth		Position		General Locality	Date 1936	Start of Haul	Duration of Haul	
			Fathoms	Metres	N. Lat.	W. Long.				Hrs.	Mins.
125	D-1	2′ dredge	44	80	28° 13′	115° 07′	E. of Cedros Is.	Mar. 27	6:40 a.m.	0	12
126	D-1	4′ dredge	38	69	28° 07′	115° 09′	E. of Cedros Is.	27	8:30 a.m.	0	10
	D-2	4′ dredge	38	69	28° 07′	115° 09′	E. of Cedros Is.	27	9:06 a.m.	0	30
	D-3	4′ dredge	40	73	28° 07′	115° 09′	E. of Cedros Is.	May 22	10:08 a.m.	0	15
	D-4	4′ dredge	40	73	28° 08′	115° 08′	E. of Cedros Is.	22	10:56 a.m.	0	10
	D-5	4′ dredge	43	78	28° 10′	115° 08′	E. of Cedros Is.	22	11:37 a.m.	0	10
	D-6	4′ dredge	45	82	28° 11′	115° 06′	E. of Cedros Is.	22	12:06 p.m.	0	10
	D-7	4′ dredge	48	87	28° 15′	115° 08′	E. of Cedros Is.	22	1:52 p.m.	0	10
	D-8	4′ dredge	48	87	28° 16′	115° 09′	E. of Cedros Is.	22	2:16 p.m.	0	10
	D-9	4′ dredge	56	102	28° 20′	115° 09′	E. of Cedros Is.	22	3:12 p.m.	0	10
	D-10	4′ dredge	60	109	28° 22′	115° 10′	E. of Cedros Is.	22	3:39 p.m.	0	20
	D-11	4′ dredge	44	80	28° 21′	115° 11′	E. of Cedros Is.	22	4:37 p.m.	0	20
	D-12	4′ dredge	45	82	28° 20′	115° 10′ 30″	E. of Cedros Is.	22	5:20 p.m.	0	20
	T-1	Metre	0	0	28° 20′	115° 10′ 30″	E. of Cedros Is.	22	6:06 p.m.	0	20
127	D-1	4′ dredge	38	69	28° 05′	115° 09′	E. of Cedros Is.	Mar. 27	10:25 a.m.	0	30
128	D-1	4′ dredge	39	71	28° 03′	115° 09′	E. of Cedros Is.	27	11:23 a.m.	0	30
129	T-1	Metre	4	7	27° 22′	114° 44′	15 m. NW. of San Pablo Point.	27	8:15 p.m.	0	30
130	T-1	Metre	400	732	25° 17′	113° 25′	68 m. WNW. of Cape San Lasaro.	28	4:30 p.m.	1	00
	T-2	Foot	0	0	25° 17′	113° 25′	68 m. WNW. of Cape San Lasaro.	28	5:06 p.m.	0	20
131	D-1	2′ dredge	12	22	24° 36′ 30″	112° 07′ 30″	Magdalena Bay.	29	10:30 a.m.	0	30
132	T-1	Metre	0	0	24° 27′	112° 00′	4 m. S. of Redondo Pt., Magdalena Bay.	29	3:06 p.m.	0	20
133	—	Light	—	—	24° 09′	111° 43′	9 m. S. of Santa Margarita Is.	29	8:00 p.m.	1	0
134	T-1	Foot	0	0	22° 44′	110° 08′	12 m. SW. of Cape Falso.	30	2:43 p.m.	0	20
	T-2	½ Metre	450	820	22° 44′	110° 08′	12 m. SW. of Cape Falso.	30	2:12 p.m.	1	0
	T-3	Metre	550	1000	22° 44′	110° 08′	12 m. SW. of Cape Falso.	30	2:12 p.m.	1	0
135	D-1	2′ dredge	8–16	14–29	22° 53′	109° 54′	San Lucas Bay.	31	10:00 a.m.	0	10
	D-2	2′ dredge	8–16	14–29	22° 53′	109° 54′	San Lucas Bay.	31	10:20 a.m.	0	10
	D-3	2′ dredge	8–16	14–29	22° 53′	109° 54′	San Lucas Bay.	April 1	11:00 a.m.	0	10
	D-4	2′ dredge	8–16	14–29	22° 53′	109° 54′	San Lucas Bay.	2	10:20 a.m.	0	10
	D-5	2′ dredge	8–16	14–29	22° 53′	109° 54′	San Lucas Bay.	2	10:40 a.m.	0	10
	D-6	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	May 6	10:00 a.m.	0	5
	D-7	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	6	10:15 a.m.	0	5
	D-8	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	6	10:20 a.m.	0	5
	D-9	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	6	10:30 a.m.	0	5
	D-10	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	6	10:45 a.m.	0	5
	D-11	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	6	11:00 a.m.	0	5
	D-12	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	6	11:15 a.m.	0	5
	D-13	2′ dredge	2	3.6	22° 53′	109° 54′	San Lucas Bay.	6	11:30 a.m.	0	5
	D-14	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	6	11:45 a.m.	0	5
	D-15	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	6	12:00 p.m.	0	5
	D-16	2′ dredge	6–20	11–36	22° 53′	109° 54′	San Lucas Bay.	6	12:10 p.m.	0	5
	D-17	2′ dredge	20	36	22° 53′	109° 54′	San Lucas Bay.	7	9:15 a.m.	0	10
	D-18	2′ dredge	4	7.5	22° 53′	109° 54′	San Lucas Bay.	7	9:25 a.m.	0	10
	D-19	2′ dredge	3	5.5	22° 53′	109° 54′	San Lucas Bay.	7	9:30 a.m.	0	10

STATION LISTS AND DATA (*continued*).

Station No.	Net No.	Type of Net	Depth		Position		General Locality	Date 1936	Start of Haul	Duration of Haul	
			Fathoms	Metres	N. Lat.	W. Long.				Hrs.	Mins
								May			
135	D-20	2′ dredge	3	5.5	22° 53′	109° 54′	San Lucas Bay.	7	9:45 a.m.	0	10
	D-21	2′ dredge	6	11	22° 53′	109° 54′	San Lucas Bay.	7	10:00 a.m.	0	10
	D-22	2′ dredge	8	14.5	22° 53′	109° 54′	San Lucas Bay.	7	10:15 a.m.	0	10
	D-23	2′ dredge	9	16	22° 53′	109° 54′	San Lucas Bay.	7	10:30 a.m.	0	10
	D-24	2′ dredge	9	16	22° 53′	109° 54′	San Lucas Bay.	7	10:45 a.m.	0	10
	D-25	2′ dredge	7	13	22° 53′	109° 54′	San Lucas Bay.	7	11:00 a.m.	0	10
	D-26	2′ dredge	13	24	22° 53′	109° 54′	San Lucas Bay.	7	11:15 a.m.	0	10
								April			
136	D-1	4′ dredge	45	82	23° 29′	109° 25′	Arena Bank.	3	3:40 p.m.	0	20
	D-2	4′ dredge	45	82	23° 30′ 30″	109° 26′	Arena Bank.	3	4:27 p.m.	0	20
	D-3	4′ dredge	45	82	23° 31′	109° 27′	Arena Bank.	3	5:17 p.m.	0	20
	D-4	4′ dredge	55	100	23° 32′	109° 27′	Arena Bank.	19	3:52 p.m.	0	4
	D-5	4′ dredge	33	60	23° 31′	109° 27′ 30″	Arena Bank.	19	4:45 p.m.	0	5
	D-6	4′ dredge	35	64	23° 30′	109° 26′	Arena Bank.	19	5:17 p.m.	0	10
	D-7	4′ dredge	55	100	23° 31′	109° 26′	Arena Bank.	19	5:35 p.m.	0	15
	D-8	4′ dredge	45	82	23° 30′	109° 25′ 30″	Arena Bank.	20	9:04 a.m.	0	10
	D-9	4′ dredge	45	82	23° 30′ 30″	109° 26′	Arena Bank.	20	9:27 a.m.	0	8
	D-10	4′ dredge	45	82	23° 30′	109° 25′ 30″	Arena Bank.	20	10:21 a.m.	0	10
	D-11	4′ dredge	30–45	55–82	23° 29′	109° 25′	Arena Bank.	20	10:50 a.m.	0	8
	D-12	4′ dredge	35	64	23° 28′	109° 24′ 30″	Arena Bank.	20	11:22 a.m.	0	10
	D-13	4′ dredge	45	82	23° 29′	109° 24′	Arena Bank.	20	11:46 a.m.	0	10
	D-14	4′ dredge	45	82	23° 29′ 30″	109° 25′	Arena Bank.	20	12:12 p.m.	0	10
	D-15	4′ dredge	40	73	23° 28′ 30″	109° 25′	Arena Bank.	20	3:14 p.m.	0	10
	D-16	4′ dredge	45	82	23° 29′ 30″	109° 25′ 30″	Arena Bank.	20	3:42 p.m.	0	18
	D-17	4′ dredge	45	82	23° 30′ 30″	109° 26′	Arena Bank.	20	4:46 p.m.	0	15
	D-18	4′ dredge	40	73	23° 30′	109° 25′	Arena Bank.	20	5:20 p.m.	0	10
	D-19	4′ dredge	50	91	23° 31′ 30″	109° 27′	Arena Bank.	30	8:57 a.m.	0	9
	D-20	4′ dredge	43	78	23° 30′	109° 26′	Arena Bank.	30	9:51 a.m.	0	15
	D-21	4′ dredge	45	82	23° 29′	109° 25′	Arena Bank.	30	10:49 a.m.	0	8
	D-22	4′ dredge	45	82	23° 28′ 30″	109° 25′	Arena Bank.	30	11:40 a.m.	0	11
	D-23	4′ dredge	40	73	23° 28′	10. ° 24′	Arena Bank.	30	1:44 p.m.	0	10
	D-24	4′ dredge	50	91	23° 29′	109° 23′ 30″	Arena Bank.	30	2:19 p.m.	0	10
	D-25	4′ dredge	60–80	109–145	23° 29′ 30″	109° 23′	Arena Bank.	30	3:09 p.m.	0	10
								May			
	D-26	4′ dredge	45	82	23° 27′	10: ° 24′	Arena Bank.	1	9:19 a.m.	0	10
	D-27	4′ dredge	50	91	23° 28′	10 ° 24′	Arena Bank.	1	10:25 a.m	0	4
	D-28	4′ dredge	85	154	23° 29′	10 ° 23′ 30″	Arena Bank.	1	11:46 a.m.	0	14
	D-29	4′ dredge	70	128	23° 26′	109° 24′	Arena Bank.	1	2:20 p.m.	0	5
	D-30	4′ dredge	35	64	23° 27′	109° 24′	Arena Bank.	1	3:27 p.m.	0	5
	D-31	4′ dredge	35	64	23° 28′	109° 23′ 30″	Arena Bank.	1	4:27 p.m.	0	10
	D-32	4′ dredge	42	76	23° 24′ 30″	109° 24′	Arena Bank.	2	12:09 p.m.	0	10
	D-33	—	2–3	4–6	23° 26′	109° 24′ 30″	Arena Bank.	2	10:30 a.m	—	—
								April			
137	D-1	4′ dredge	46	84	24° 09′	109° 57′	Ceralbo Channel	4	9:44 a.m.	0	20
	D-2	4′ dredge	46	84	24° 11′	10 ° 59′	Ceralbo Channel	4	10:29 a.m.	0	20
	D-3	4′ dredge	46	84	24° 12′	110° 00′	Ceralbo Channel	4	11:05 a.m.	0	20
138	—	Light	—	—	24° 55′	110° 20′	10 m. E. of San Jose Island.	4	8:30 p.m.	2	0
139	T-1	½ Metre	1	2	27° 23′	111° 26′	23 m. ExS. of Tortuga Island.	8	2:00 p.m.	0	20
	T-2	Metre	300	549	27° 23′	111° 26′	23 m. ExS. of Tortuga Island.	8	1:23 p.m.	2	0
	T-3	Metre	400	732	27° 23′	111° 26′	23 m. ExS. of Tortuga Island.	8	1:23 p.m.	2	0
	T-4	Metre	500	914	27° 23′	111° 26′	23 m. ExS. of Tortuga Island.	8	1:23 p.m.	2	0

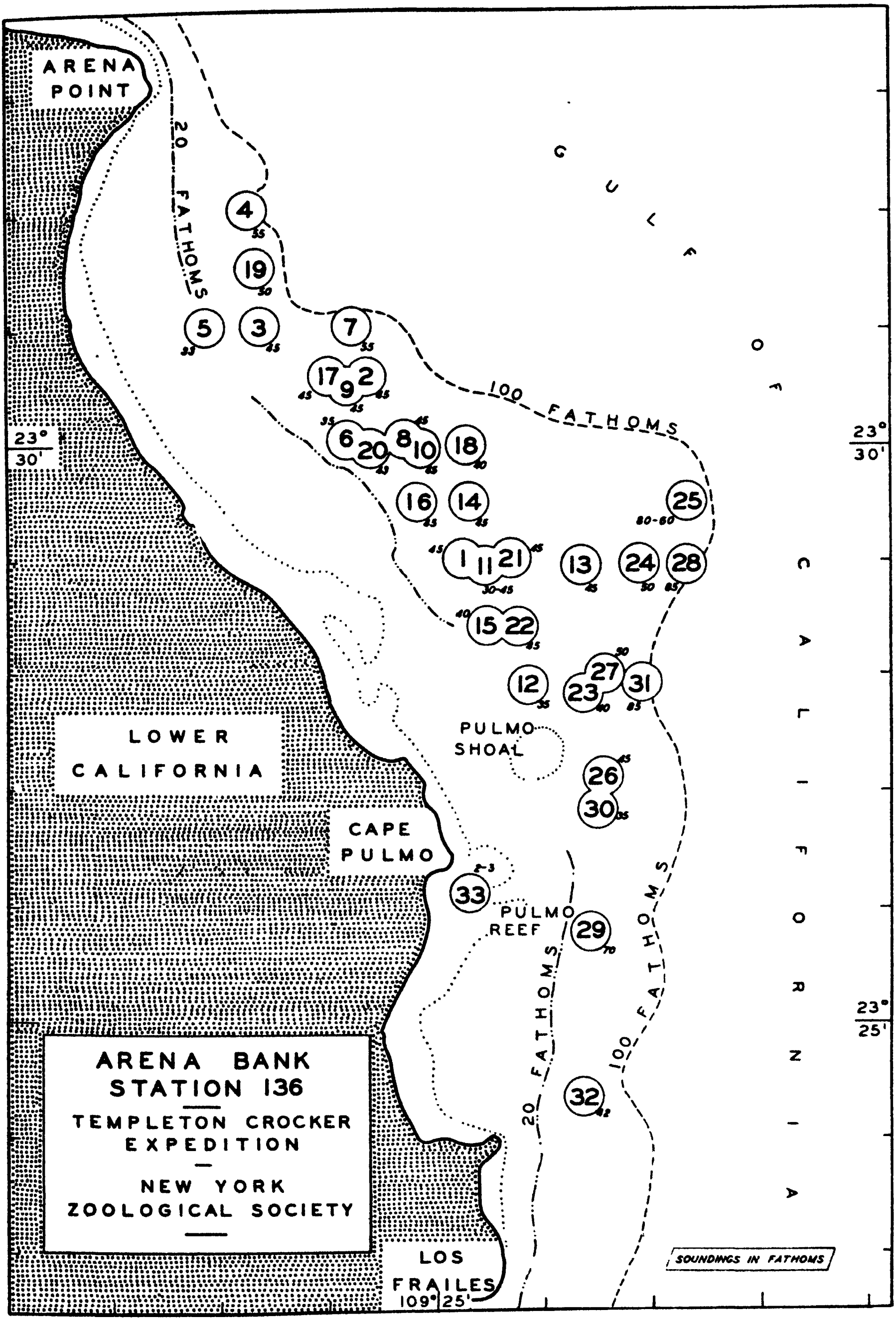


Text-figure 4.

Dredging Stations of the *Zaca* near the East coast of Cedros Island, Lower California, Nos. 125 to 128. The upper number within the circle is the station number, the lower the dredge number. The small figure in italics is the depth in fathoms.

STATION LISTS AND DATA (*continued*).

Station No.	Net No.	Type of Net	Depth		Position		General Locality	Date 1936	Start of Haul	Duration of Haul	
			Fathoms	Metres	N. Lat.	W. Long.				Hrs.	Mins.
								April			
140	T-1	Metre	0	0	27° 00′	111° 57′	Santa Ines Bay	9	8:58 p.m.	0	10
	T-2	Mbtre	0	0	27° 00′	111° 57′	Santa Ines Bay	10	2:03 p.m.	0	10
141	D-1	4′ dredge	7–9	13–16	27° 02′	111° 58′	Santa Ines Bay	10	9:30 a.m.	0	20
	D-2	4′ dredge	10–15	18–27	27° 01′	111° 58′ 30″	Santa Ines Bay.	10	10:02 a.m.	0	20
	D-3	4′ dredge	18	33	27° 00′ 30″	111° 58′ 30″	Santa Ines Bay.	10	10:32 a.m.	0	20
	D-4	4′ dredge	20	36	26° 59′ 30″	111° 59′	Santa Ines Bay.	10	11:03 a.m.	0	20
142	D-1	4′ dredge	30	54	27° 05′	111° 56′	Santa Iner Bay.	11	8:51 a.m.	0	02
	D-2	4′ dredge	30–35	54–64	27° 04′	111° 55′	Santa Ines Bay.	11	9:22 a.m.	0	10
	D-3	4′ dredge	40	73	27° 04′	111° 54′	Santa Ines Bay.	11	10:05 a.m.	0	20
	D-4	4′ dredge	40–50	73–91	27° 03′	111° 53′ 30″	Santa Ines Bay.	11	10:42 a.m.	0	20
	T-1	Metre	0	0	27° 04′	111° 55′	Santa Ines Bay.	11	11:32 a.m.	0	10
143	D-1	4′ dredge	29	53	26° 58′ 30″	111° 57′ 30″	Santa Ines Bay.	13	8:57 a.m.	0	20
	D-2	4′ dredge	30	55	26° 58′	111° 56′ 30″	Santa Ines Bay.	13	10:29 a.m.	0	10
	D-3	4′ dredge	35	64	26° 57′	111° 56′	Santa Ines Bay.	13	10:58 a.m.	0	10
	D-4	4′ dredge	25	46	26° 55′	111° 54′	Santa Ines Bay.	13	11:59 a.m.	0	6
	D-5	4′ dredge	18	33	26° 54′	111° 53′	Santa Iner Bay.	13	12:30 p.m.	0	10
144	D-1	2′ dredge	1	2	26° 50′ 45″	111° 54′ 20″	Santa Ines Bay.	15	9:50 a.m.	0	5
	D-2	2′ dredge	2½	4.5	26° 50′ 45″	111° 54′ 20″	Santa Ines Bay.	15	10:05 a.m.	0	5
	D-3	2′ dredge	2½	4.5	26° 50′ 45″	111° 54′ 20″	Santa Ines Bay.	15	10:12 a.m.	0	5
	D-4	2′ dredge	1½–4	3–7.5	26° 50′ 45″	111° 54′ 20″	Santa Ines Bay	15	10:23 a.m.	0	5
	D-5	2′ dredge	4	7.5	26° 50′ 45″	111° 54′ 20″	Santa Ines Bay.	15	10:30 a.m.	0	5
	D-6	2′ dredge	3½	6.5	26° 50′ 45″	111° 54′ 20″	Santa Ines Bay.	15	10:40 a.m.	0	5
	D-7	2′ dredge	3	5.5	26° 50′ 45″	111° 54′ 20″	Santa Iner Bay.	15	10:50 a.m.	0	6
	D-8	2′ dredge	3	5.5	26° 50′ 45″	111° 54′ 20″	Santa Ines Bay.	15	11:00 a.m.	0	5
145	D-1	2′ dredge	13	24	26° 52′	111° 53′	Santa Ines Bay.	16	5:20 p.m.	0	5
	D-2	2′ dredge	6–8	11–14	26° 52′	111° 53′	Santa Ines Bay.	16	5:30 p.m.	0	5
	D-3	2′ dredge	4	7.5	26° 52′	111° 53′	Santa Ines Bay.	16	5:40 p.m.	0	5
	T-1	Metre	0	0	26° 52′	111° 53′	Santa Ines Bay.	14	9:00 p.m.	0	10
	T-2	Metre	0	0	26° 52′	111° 53′	Santa Ines Bay.	16	1:20 p.m.	0	10
146	D-1	4′ dredge	35	64	26° 54′ 20″	111° 48′ 45″	Santa Iner Bay.	17	8:41 a.m.	0	15
147	D-1	4′ dredge	83	150	26° 56′	111° 47′ 15″	Santa Ines Bay.	17	9:45 a.m.	0	15
	D-2	4′ dredge	60	110	26° 57′ 30″	111° 48′ 30″	Santa Ines Bay.	17	10:54 a.m.	0	15
148	T-1	½ Metre	0	0	26° 48′ 40″	111° 20′ 30″	13 m. NNE. of San Ildefonso Is.	17	4:10 p.m.	0	25
	T-2	Metre	300	549	26° 48′ 40″	111° 20′ 30″	13 m. NNE. of San Ildefonso Is.	17	3:45 p.m.	1	20
	T-3	Metre	400	732	26° 48′ 40″	111° 20′ 30″	13 m. NNE. of San Ildefonso Is.	17	3:45 p.m.	1	20
	T-4	Metre	500	914	26° 48′ 40″	111° 20′ 30″	13 m. NNE. of San Ildefonso Is.	17	3:45 p.m.	1	20
	T-5	½ Metre	0	0	26° 48′	111° 15′	20 m. NE. of San Ildefonso Is.	17	9:11 p.m.	0	25
	T-6	Metre	300	549	26° 48′	111° 15′	20 m. NE. of San Ildefonso Is.	17	9:03 p.m.	1	20
	T-7	Metre	400	732	26° 48′	111° 15′	20 m. NE. of San Ildefonso Is.	17	9:03 p.m.	1	20
	T-8	Metre	500	914	26° 48′	111° 15′	20 m. NE. of San Ildefonso Is.	17	9:03 p.m.	1	20
149	—	Light	—	—	25° 25′	110° 33′	10 m. NE. of Santa Cruz Is.	18	8:40 p.m.	0	50
150	D-1	4′ dredge	93	169	23° 01′ 30″	109° 29′	Gorda Banks.	21	1:39 p.m.	0	10
	D-2	4′ dredge	75	137	23° 01′	109° 28′	Gorda Banks.	21	2:20 p.m.	0	10
	D-3	4′ dredge	58	106	23° 00′	109° 28′	Gorda Banks.	21	2:54 p.m.	0	10
	D-4	4′ dredge	70	128	23° 01′	109° 29′	Gorda Banks.	21	3:30 p.m.	0	10
	D-5	4′ dredge	40–100	73–182	23° 01′ 30″	109° 30′	Gorda Banks.	21	4:11 p.m.	0	10
	D-6	4′ dredge	60	109	23° 02′	109° 31′	Gorda Banks.	21	5:16 p.m.	0	10

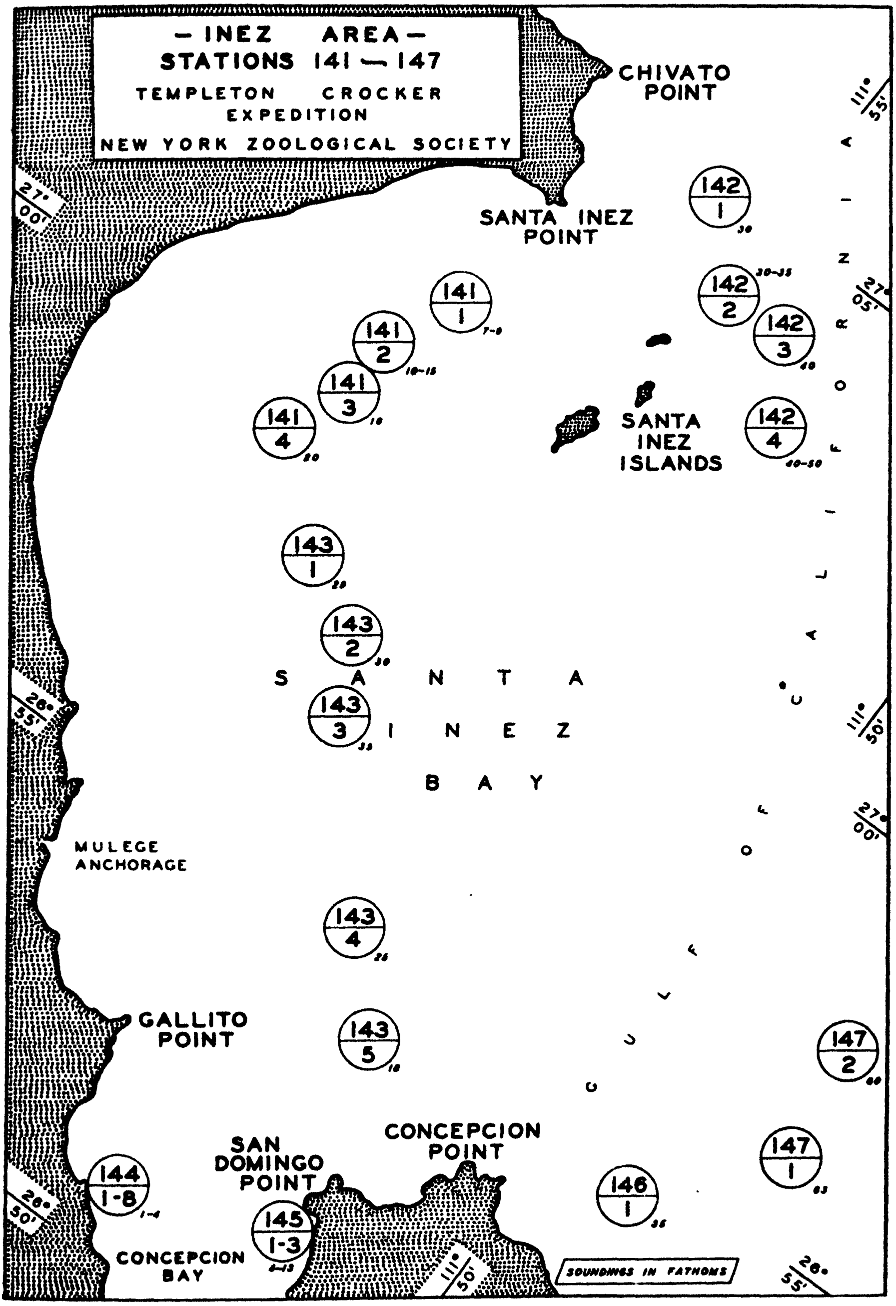


Text-figure 5.

Dredging Stations of the *Zaca* on Arena Bank, Gulf of California, Station 136. The number within the circle is the dredge number. The small figure in italics represents the depth in fathoms.

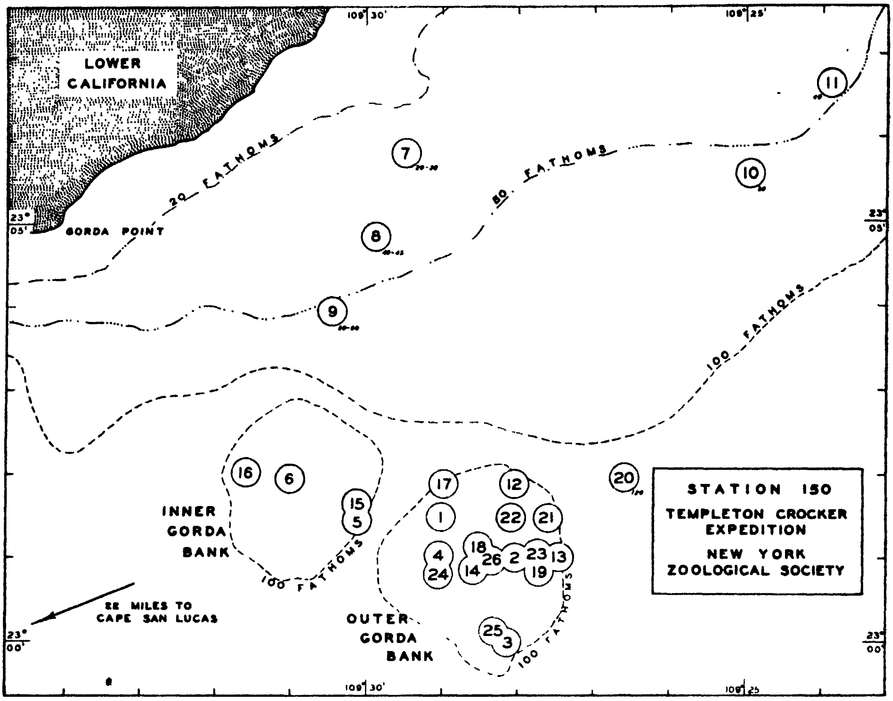
STATION LISTS AND DATA (*continued*).

Station No.	Net No.	Type of Net	Depth: Fathoms	Depth: Metres	Position: N. Lat.	Position: W. Long.	General Locality	Date 1936	Start of Haul	Duration of Haul: Hrs.	Duration of Haul: Mins.
								April			
150	D-7	4′ dredge	20–30	36–55	23° 06′	109° 29′ 30″	Gorda Banks.	22	9:11 a.m.	0	2
	D-8	4′ dredge	40–45	73–82	23° 05′	109° 30′	Gorda Banks.	22	9:35 a.m.	0	10
	D-9	4′ dredge	50–60	91–109	23° 04′	109° 30′ 30″	Gorda Banks.	22	10:07 a.m.	0	5
	D-10	4′ dredge	50	91	23° 06′	109° 25′	Gorda Banks.	22	2:44 p.m.	0	½
	D-11	4′ dredge	40	73	23° 07′	109° 24′	Gorda Banks.	22	3:29 p.m.	0	0
	D-12	4′ dredge	80–90	145–165	23° 02′	109° 28′	Gorda Banks.	22	5:36 p.m.	0	10
	D-13	4′ dredge	70–80	128–146	23° 01′	109° 27′ 30″	Gorda Banks.	23	9:12 a.m.	0	20
	D-14	4′ dredge	60	109	23° 01′	109° 28′ 30″	Gorda Banks.	23	9:58 a.m.	0	20
	D-15	4′ dredge	80	146	23° 01′ 30″	109° 30′	Gorda Banks.	23	10:43 a.m.	0	15
	D-16	4′ dredge	67–75	122–136	23° 02′	109° 30′ 30″	Gorda Banks.	23	11:22 a.m.	0	11
								May			
	D-17	4′ dredge	90	165	23° 02′	109° 29′	Gorda Banks.	3	8:43 a.m.	0	7
	D-18	4′ dredge	60	109	23° 01′	109° 28′ 30″	Gorda Banks.	3	9:19 a.m.	0	10
	D-19	4′ dredge	50	91	23° 01′	109° 27′ 30″	Gorda Banks.	3	10:13 a.m.	0	10
	D-20	4′ dredge	120	219	23° 02′	109° 26′ 30″	Gorda Banks.	3	10:53 a.m.	0	12
	D-21	4′ dredge	80	146	23° 01′ 30″	109° 27′	Gorda Banks.	3	1:34 p.m.	0	10
	D-22	4′ dredge	68	124	23° 01′ 30″	109° 28′	Gorda Banks.	3	2:14 p.m.	0	15
	D-23	4′ dredge	45	82	23° 01′	109° 27′ 30″	Gorda Banks.	3	3:02 p.m.	0	10
	D-24	4′ dredge	60	109	23° 01′	109° 29′	Gorda Banks.	3	3:38 p.m.	0	10
	D-25	4′ dredge	56	102	23° 00′	109° 28′	Gorda Banks.	3	4:13 p.m.	0	10
	D-26	4′ dredge	55	100	23° 01′	109° 28′ 30″	Gorda Banks.	3	4:44 p.m.	0	11
								April			
	T-1	Metre	0	0	23° 01′ 30″	109° 29′	Gorda Banks.	21	1:20 p.m.	0	10
	T-2	Metre	0	0	23° 03′	109° 30′	Gorda Banks.	21	9:30 p.m.	0	10
	T-3	Metre	0	0	23° 06′	109° 25′	Gorda Banks.	22	12:50 p.m.	0	10
151	D-1	4′ dredge	65	128	22° 51′ 30″	109° 54′	3 m. E. of Cape Falso.	24	8:48 a.m.	0	10
	D-2	4′ dredge	60	109	22° 51′	109° 55′	3 m. E. of Cape Falso.	24	9:18 a.m.	0	5
152	—	Light	—	—	23° 00′	108° 11′	80 m. E. of San Jose del Cabo.	26	9:00 p.m.	0	45
153	D-1	4′ dredge	120	218	23° 06′	106° 47′	19 m. W. of Mazatlan.	27	9:24 a.m.	0	5
154	D-1	4′ dredge	45	82	23° 06′	106° 35′	4½ m. SW. of Mazatlan.	27	10:49 a.m.	0	5
	D-2	4′ dredge	35	64	23° 07′	106° 32′	4½ m. SW. of Mazatlan.	27	11:11 a.m.	0	20
155	D-1	4′ dredge	56	102	23° 12′	106° 40′	13 m. W. of Mazatlan.	28	8:42 a.m.	0	20
	D-2	4′ dredge	60	109	23° 12′	106° 42′	13 m. W. of Mazatlan.	28	9:25 a.m.	0	11
156	D-1	4′ dredge	135	246	23° 13′	106° 52′	21 m. W. of Mazatlan.	28	11:42 a.m.	0	20
	D-2	4′ dredge	235	428	23° 13′	106° 54′	21 m. W. of Masaltan.	28	2:17 p.m.	0	20
	D-3	4′ dredge	235	428	23° 15′	106° 56′	21 m. W. of Mazatlan.	28	3:46 p.m.	0	30
157	T-1	Metre	1	2	23° 20′	107° 17′	47 m. W. of Mazatlan.	28	9:16 p.m.	0	20
	T-2	Metre	300	549	23° 20′	107° 17′	47 m. W. of Mazatlan.	28	9:02 p.m.	1	0
158	T-1	½ Metre	1	2	23° 25′	108° 31′	48 m. E. of Arena Point.	29	9:36 a.m.	0	20
	T-2	Metre	300	549	23° 25′	108° 31′	48 m. E. of Arena Point.	29	9:09 a.m.	1	0
	T-3	Metre	400	732	23° 25′	108° 31′	48 m. E. of Arena Point.	29	9:00 a.m.	1	0



Text-figure 6.

Dredging Stations of the *Zaca* in the Inez Bay Area, Gulf of California, Stations 141 to 147. The upper number within the circle is the station number, the lower the dredge number. The small figure in italics represents the depth in fathoms.

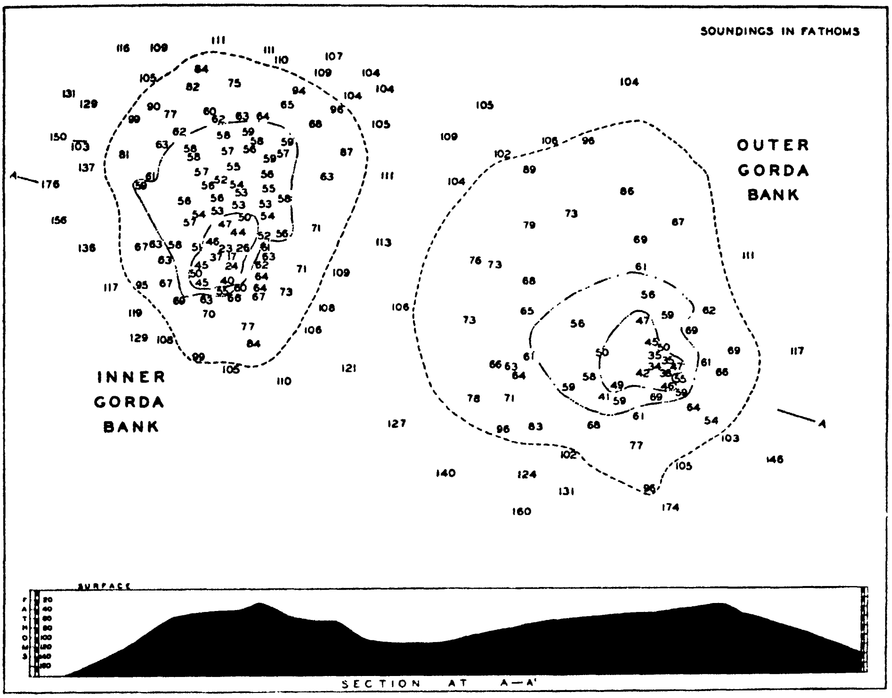


Text-figure 7.

Dredging Stations of the *Zaca* on the Gorda Banks and vicinity, southern tip of Lower California, Station 150. The numbers within the circles are the numbers of the dredges. The small figure in italics represents the depth in fathoms.

STATION LISTS AND DATA (*continued*).

Station No.	Net No.	Type of Net	Depth		Position		General Locality	Date 1936	Start of Haul	Duration of Haul	
			Fathoms	Metres	N. Lat.	W. Long.				Hrs.	Mins.
158	T-4	Metre	500	914	23° 25′	108° 31′	48 m. E. of Arena Point.	April 29	9:09 a.m.	1	0
159	T-1	Metre	300	549	23° 27′	108° 49′	34 m. ExS. of Arena Point.	29	2:34 p.m.	2	30
	T-2	Metre	400	732	23° 27′	108° 49′	34 m. ExS. of Arena Point.	29	2:34 p.m.	2	30
	T-3	Metre	500	914	23° 27′	108° 49′	34 m. ExS. of Arena Point.	29	2:34 p.m.	2	30
160	—	Light	—	—	22° 30′	110° 15′	27 m. SW. of Cape Falso.	May 7	8:45 p.m.	0	40
161	T-1	Metre	0	0	20° 40′	112° 10′	185 m. SW. of Cape Falso.	8	9:50 p.m.	0	10
	—	Light	—	—	20° 40′	112° 10′	185 m. SW. of Cape Falso.	8	8:50 p.m.	1	0
162	—	Light	—	—	18° 44′	114° 20′	30 m. NE. of Clarion Is.	9	9:00 p.m.	2	0



Text-figure 8.
Soundings in fathoms on the Gorda Banks, and section of the Banks at the line A-A. The soundings are from the original surveys of the Banks and were supplied through the courtesy of the Hydrographic Office, U.S. Navy.

STATION LISTS AND DATA (*continued*).

Station No.	Net No.	Type of Net	Depth		Position		General Locality	Date 1936	Start of Haul	Duration of Haul	
			Fathoms	Metres	N. Lat.	W. Long.				Hrs.	Mins.
163	D-1	2′ dredge	20	36	18° 20′ 40″	114° 44′ 20″	Sulphur Bay, Clarion Is.	11	3:40 p.m.	0	20
	D-2	4′ dredge	55	100	18° 19′	114° 45′	3 m. off Pyramid Rock, Clarion Is.	12	9 16 a.m.	0	10
	D-3	4′ dredge	50	91	18° 19′ 30″	114° 44′ 30″	3 m. off Pyramid Rock, Clarion Is.	12	9:40 a.m	0	1
	D-4	4′ dredge	50	91	18° 20′	114° 43′	3 m. off Pyramid Rock, Clarion Is.	12	10:38 a.m.	0	10
	D-5	4′ dredge	48	87	18° 20′ 30″	114° 42′ 30″	3 m. off Pyramid Rock, Clarion Is.	12	10:59 a.m.	0	0
	D-6	4′ dredge	45	82	18° 20′	114° 42′	3 m. off Pyramid Rock, Clarion Is.	12	11:27 a.m	0	1
	T-1	Metre	0	0	18° 20′ 40″	114° 44′ 20″	Sulphur Bay, Clarion Island.	10	1:15 p.m.	0	10
	T-2	Metre	0	0	18° 20′ 40″	114° 44′ 20″	Sulphur Bay, Clarion Island.	10	9:00 p.m.	0	10
	T-3	Metre	0	0	18° 20′ 40″	114° 44′ 20″	Sulphur Bay, Clarion Island.	11	12:45 p.m.	0	10

STATION LISTS AND DATA (*continued*)

Station No.	Net No.	Type of Net	Depth: Fathoms	Depth: Metres	Position: N. Lat.	Position: W. Long.	General Locality	Date 1936	Start of Haul	Duration of Haul: Hrs.	Duration of Haul: Mins.
	T-4	Metre	0	0	18° 20′ 40″	114° 44′ 20″	Sulphur Bay, Clarion Island	May 11	9:15 p.m.	0	10
	T-5	Metre	0	0	18° 20′ 40″	114° 44′ 20″	Sulphur Bay, Clarion Island.	12	9:30 p.m.	0	10
	T-6	Metre	0	0	18° 20′ 40″	114° 44′ 20″	Sulphur Bay, Clarion Island.	12	9:50 p.m.	0	10
	T-7	Metre	0	0	18° 20′ 40″	114° 44′ 20″	Sulphur Bay, Clarion Island.	13	10:20 a.m.	0	10
164	—	Light	—	—	19° 20′	114° 55′	58 m. N. of Clarion Island.	16	9:05 p.m.	0	20
165	T-1	½ Metre	0	0	20° 36′	115° 07′	145 m. N. of Clarion Island.	17	12:05 p.m.	0	30
	T-2	Metre	400	732	20° 36′	115° 07 ′	145 m. N. of Clarion Island.	17	9:52 a.m.	3	0
	T-3	Metre	500	914	20° 36′	115° 07′	145 m. N. of Clarion Island.	17	9:52 a.m.	3	0
	T-4	Metre	600	1097	20° 36′	115° 07′	145 m. N. of Clarion Island.	17	9:52 a.m.	3	0
166	—	Surface	—	—	21° 12′	115° 11′	173 m. N. of Clarion Island.	17	5:15 p.m.	0	30
167	—	Light	—	—	21° 20′	115° 14′	183 m. N. of Clarion Island.	17	9:00 p.m.	0	20
168	T-1	Metre	1–2	2–4	24° 38′	115° 42′	20 m. S. of Alijos Rocks.	19	11:22 a.m.	0	20
169	T-1	Metre	2	4	24° 57′	115° 48′	½ m. E of Alijos Rocks.	19	4:38 p.m.	0	20
170	—	Light	—	—	25° 02′	115° 52′	5½ m. N. of Alijos Rocks.	19	9:00 p.m.	0	12
	T-1	Metre	2	4	25° 02′	115° 52′	5½ m. N. of Alijos Rocks.	19	7:59 p.m.	0	20
171	T-1	Metre	1	2	27° 19′	115° 05′	50 m. SW. of Cedros Island.	21	12:20 p.m.	0	20
172	—	Light	—	—	28° 33′	115° 15′	12 m. N. of Cedros Island.	22	9:15 p.m.	0	20
173	T-1	½ Metre	0	0	29° 35′	116° 20′	30 m. W. of Point Antonio	23	2:57 p.m.	1	0
174	—	Light	—	—	30° 00′	116° 27′	30 m. SW. of Cape San Quentin.	23	9:00 p.m.	0	20
175	D-1	4′ dredge	45	80	31° 25′	116° 42′	5 m. W. of San Jose Point.	24	10:28 a.m.	0	10
	D-2	4′ dredge	45	80	31° 25′ 30″	116° 42′ 30″	5 m. W. of San Jose Point.	24	10:54 a.m	0	10
	D-3	4′ dredge	45	80	31° 26′	116° 43′	5 m. W. of San Jose Point.	24	11:15 a.m.	0	10
	T-1	½ Metre	2	4	31° 26′	116° 43′	5 m. W. of San Jose Point.	24	11:40 a.m.	0	10

3.

The Templeton Crocker Expedition. III. Brachygnathous Crabs from the Gulf of California and the West Coast of Lower California.[1]

JOCELYN CRANE

Technical Associate, Department of Tropical Research, New York Zoological Society.

(Plates I-VIII).

[Note: This is the third of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica*, No. 2, pp. 33 to 46.]

CONTENTS.

[1] Contribution No. 521, Department of Tropical Research. New York Zoological Society.

SUMMARY OF IMPORTANT POINTS.

The most interesting features of the present collection and report may be summarized as follows:

1. The following paper records all of the brachygnathous crabs taken by the Templeton Crocker Expedition with the exception of the specimens taken at Clarion Island.

2. The total of 73 species is more than one-third of all of the brachygnathous crabs previously recorded from the Gulf of California and the west coast of Lower California.

3. The collection contains the following 7 new species: *Mithrax mexicanus* Glassell, ***Stenocionops beebei*** Glassell, *Actaea crockeri* Glassell, *Pilumnus pelagius* Glassell, *Chasmocarcinus ferrugineus* Glassell, *Cymopolia zacae* Glassell and *Cymopolia cortezi*, sp. nov. The last species is described in the present paper; the others, described by Mr. Steve A. Glassell, will be found in *Zoologica*, Vol. XXI, No. 17, pp. 213-218.

4. The 4 following species have not been reported previously from the Gulf of California-Lower California area: *Rochinia vesicularis* (previously known only from the Galápagos), *Parthenope* (*Pseudolambrus*) *excavata* (previously known only from Panama and Manzanillo), *Ovalipes punctatus* (a cosmopolitan species not recorded before in the eastern Pacific north of Peru), and *Trapezia cymodoce ferruginea* (a cosmopolitan species not previously recorded in the eastern Pacific north of the Revilla Gigedos Islands).

5. The 12 following species, while they have been known from the western coast of Lower California or from Cape San Lucas or both, have not been reported previously from the Gulf of California: *Podochela barbarensis*, *Inachoides laevis*, *Erileptus spinosus*, *Lissa aurivilliusi*, *Pitho sexdentata*, *Mithrax* (*Mithrax*) *tuberculatus*, *Macrocoeloma villosum*, *Medaeus lobipes*, *Micropanope polita*, *Trapezia digitalis*, *Chasmocarcinus latipes* and *Cymopolia lucasii*.

6. The vertical ranges of the 20 following species have been extended in either or both directions by more than 5 fathoms: *Stenorhynchus debilis*, *Podochela barbarensis*, *Podochela latimanus*, *Inachoides laevis*, *Euprognatha bifida*, *Collodes tumidus*, *Dasygyius depressus*, *Rochinia vesicularis*, *Mithrax* (*Mithrax*) *sinensis*, *Mithrax* (*Mithrax*) *spinipes*, *Stenocionops contigua*, *Tyche lamellifrons*, *Parthenope* (*Platylambrus*) *exilipes*, *Portunus minimus*, *Portunus pichilinquei*, *Micropanope nitida*, *Quadrella nitida*, *Chasmocarcinus latipes*, *Cymopolia lucasii*, and *Cymopolia zonata*.

7. Color notes and sketches were secured in the field from many living specimens. The "Color in Alcohol" notes were all made within 4 months of the capture of the crabs.

8. Food analyses and egg counts have been made in numerous instances, studies which have not been undertaken before on crabs from this area. It is planned to correlate and tabulate these results (which in the present paper appear under the names of the various species) in ecological papers which are now in course of preparation. It should be stated here that in every case the number of eggs carried by specimens of the same species varied directly with the size of the female.

INTRODUCTION.

Relatively little taxonomic discussion has been found necessary in the study of the present collection, thanks to Mary J. Rathbun's splendid monographs[2] on the crabs of America. Since her nomenclature and synonymy are followed throughout, references are omitted except to the few species which have been described since the publication of the monographs.

Length and breadth measurements were made as follows: Length, from the most anterior tip of the rostrum to the middle of the posterior edge of the carapace, unless otherwise stated. Breadth, the maximum width of the carapace, unless otherwise stated.

The catalogue numbers given all refer to specimens in the collections of the Department of Tropical Research of the New York Zoological Society.

The photographs are the painstaking work of Mrs. Ruth Needham Nauss.

[2]M. J. Rathbun: 1918. The Grapsoid Crabs of America. *Bull.* 97, *U. S. Nat. Mus.*; 1925, The Spider Crabs of America, *Bull.* 129, *U. S. Nat. Mus.*; 1930, The Cancroid Crabs of America of the Families Eurydalidae, Portunidae, Atelecyclidae, Cancridae and Xanthidae, *Bull.* 152, *U. S. Nat. Mus.*

My sincere thanks are due to Mr. Steve A. Glassell of the San Diego Society of Natural History for his descriptions of the 6 new species mentioned above, and for the identification of several puzzling series of specimens; to Mr. Templeton Crocker for giving me the opportunity of studying these interesting crustaceans in the field, and to Dr. William Beebe for entrusting the collection to me and for supervising the entire study.

Superfamily Oxyrhyncha.

Family Majidae.

Subfamily Inachinae.

Stenorhynchus debilis (Smith), 1871.

General Range: From Magdalena Bay, Lower California, and the Gulf of California to Chile and the Galápagos Islands. From low water mark to 50 fathoms.

Local Distribution: A total of 54 specimens was taken from San Lucas Bay (Station 135), Gorda Banks (Station 150), Arena Bank (Station 136) and the Inez area (Stations 141 and 142, and the shore of Santa Inez Point) between low water mark and 50 fathoms, on bottoms ranging from muddy or shelly to sandy or rocky with weed.

Sex and Size: Males, which measured 9 to 27 mm. in length of carapace, were almost half again as numerous as the females, which measured from 12 to 28 mm. Ovigerous females ranged from 17 to 24.5 mm. Detailed measurements of the two largest specimens in the collection are as follows: Ovigerous female, length of carapace 24.5, breadth of carapace 11, length of rostrum 11.5, length of cheliped 31 mm. Male, length of carapace 27, breadth of carapace 10, length of rostrum 15, length of cheliped about 48 mm.

Color in Life: Carapace always marked with narrow vertical and oblique, alternate stripes of dark brown, white and buff. The specimens taken on weedy bottoms, however, had a greenish cast which was wholly lacking in the crabs living in other areas. Rostrum and all legs except chelipeds reddish-brown or dull lavender mottled or barred with buff. Merus of chelipeds of adult male pale buff, the palm and fingers olive; merus of chelipeds of female and young like other legs, the palm and fingers bright orange. Carapace coloration of young like that of adult, except that the body stripes were much paler, the dark brown of grown specimens being faint tan. Eggs deep cream.

Food: An examination of fifteen stomachs of specimens from different stations showed these crabs to be omnivorous; the majority had fed either on algae or minute crustaceans (probably amphipods), but a single minute anemone was the sole content of one stomach, and a sea urchin of another.

Breeding: Ovigerous specimens numbered two-thirds of all the females, and were taken in every area in which the species was captured with the exception of San Lucas Bay.

The eggs measured .38 to .4 mm. in diameter. Four counts gave totals ranging from 215 (on a female measuring 17 mm. in length) to 975 (on a 23 mm. specimen).

Remarks: The present series extends the vertical range from 31 to 50 fathoms.

Material: *Station* 135: D-20 (1 ♂). *Station* 136: D-1 (2 ♀, 5 ♂), D-5 (1 ♀, 3 ♂), D-11 (2 ♂), D-12 (1 ♀), D-13 (1 ♀), D-14 (2 ♀, 3 ♂), D-15 (1 ♀), D-23 (1 ♂), D-24 (4 ♀, 10 ♂), D-26 (1 ♂), D-28 (1 ♀), D-30 (1 ♀, 2 ♂). *Station* 141: D-1 (1 ♀), D-4 (1 ♀). *Station* 142: D-1 (1 ♂). *Shore of Santa Inez Point*: (1 ♂). *Station* 150: D-7 (1 ♀, 2 ♂), D-8 (1 ♀), D-10 (4 ♀).

Of these 54 specimens, 29 are preserved (Cat. Nos. 36,694, 36,695, 36,696, 36,834, 36,835, 36,836).

Podochela barbarensis Rathbun, 1924.

General Range: From the Santa Barbara Islands, California, to the Gulf of California. From 1 to 60 fathoms.

Local Distribution: A total of 7 specimens was taken from the Cedros Island region (Station 126), Arena Bank (Station 136) and the Inez Area (Station 144) between 1 and 60 fathoms, on bottoms composed of sand and rocks with weed.

Sex and Size: The 4 females measured from 9.4 to 16 mm., the 3 males from 7.4 to about 20 mm. (tip of rostrum broken).

Color in Alcohol: Pale ochre, the chelipeds conspicuously banded with reddish in both sexes.

Food: Three stomachs contained large quantities of pulverized algae mixed with sand; a fourth held short lengths of algal stems.

Breeding: Two of the females (1 from the Cedros Island region and 1 from Arena Bank) were ovigerous. The former, measuring 12.3 mm. in length, carried 98 eggs .65 mm. in diameter; the latter, measuring 13.5 mm., carried 177 eggs .7 mm. in diameter.

Habits: All of the specimens carried a few pieces of weed, especially on the ambulatories. The female from Station 136 D-27 had bits of sponge attached both to her carapace and legs.

Remarks: The present collection extends the range of this species both horizontally and vertically: hitherto it was known only from the Santa Barbara Islands off California and from a series taken by the *Albatross* near Los Coronados Islands off the northern part of Lower California; these previously known specimens were taken between 38 and 50 fathoms.

Material: *Station* 126: D-10 (2 ♀, 1 ♂). *Station* 136: D-27 (1 ♀), D-31 (1 ♂). *Station* 144: D-1 (1 ♀, 1 ♂). Cat. Nos. 36,700, 36,874, 36,875.

Podochela hemphillii (Lockington), 1877.

General Range: From San Luis Obispo, California, to the Gulf of California. From 3 feet to 50 fathoms.

Local Distribution: A total of 14 specimens was taken from the shore of Magdalena Bay and from Arena Bank (Station 136) between 3 feet and 50 fathoms on various types of bottom ranging from sandy and rocky to muddy; algae usually present.

Sex and Size: The series consists of 3 ovigerous females ranging from 9.3 to 11.5 mm. in length, 3 non-ovigerous females from 7.6 to 12.4 mm., and 8 males from 7 to 16 mm.

Color in Life: Pale buff to light brown.

Food: The stomachs of specimens from Magdalena Bay contained amphipods, those from Arena Bank (about a half dozen examined) all contained algae mixed with sand.

Breeding: The 3 ovigerous females carried from 58 to 95 eggs, each measuring .59 mm. in diameter.

Habits: All 4 specimens taken from Magdalena Bay entirely lacked decoration; while those from Arena Bank all carried bits of weed, sponge and hydroids, though not nearly enough to conceal the crab.

Remarks: The 4 Magdalena males are typical *P. hemphillii* in every way. The deep-water specimens from Arena Bank differ in the following particulars: The cardiac and gastric prominences are more conspicuously elevated, even in young specimens, and the movable segments of the antennae are slightly thicker.

Material: *Shore of Magdalena Bay*: (4 ♂). *Station* 136: D-1 (2 ♀), D-11 (1 ♂), D-14 (1 ♂), D-23 (2 ♀), D-24 (2 ♀), D-30 (2 ♂). Cat. Nos. 36,699, 36,873.

Podochela latimanus (Rathbun), 1893.

General Range: Gulf of California. From 1 to 35 fathoms.

Local Distribution: A total of 9 specimens was taken from the Inez area (Stations 141, 142 and 144) between 1 and 35 fathoms, on muddy or shelly sand with weed.

Sex and Size: The 4 females, all ovigerous, ranged from 15 to about 17 mm. (rostrum broken) in length of carapace, while the 5 males were from 8.9 to about 28 mm. long. Detailed measurements of the two largest specimens were as follows: Female, length of carapace behind anterior margin of orbit 11, breadth 11, cheliped 14 mm. Male, length of carapace behind anterior margin of orbit 18, breadth 17, cheliped 28 mm. (shell soft).

Color in Alcohol: Uniformly yellow buff, more or less speckled with black in the sulci between regions and on the ventral surface. Close to the margin of the last abdominal segment in each female were two pairs of conspicuous dark circles, the two in the middle being the larger. Fingers of chelipeds with scarlet bar at or near tip in both sexes.

Food: The stomachs of 5 specimens, representing 3 dredges and both sexes, were all crammed with amphipods.

Breeding: The 4 females carried between 400 and 800 eggs ranging from .59 to .75 mm. in diameter.

Habits: Only one specimen had the least trace of weed attached to it. In contrast to other species of this genus, *P. latimanus* is characteristically smooth.

Remarks: This species has been previously recorded to a depth of only 11 fathoms.

The tip of the rostrum was broken in every specimen of the present series.

Material: *Station* 141: D-1 (1 ♂). *Station* 142: D-2 (1 ♀, 1 ♂). *Station* 144: D-1 (3 ♀, 2 ♂), D-2 (1 ♂). Cat. Nos. 36,868, 36,870, 36,871.

Podochela vestita (Stimpson), 1871.
(Plate I).

General Range: Cape San Lucas and Gulf of California. From 11 to 35 fathoms.

Local Distribution: A total of 3 specimens was taken from Arena Bank (Station 136) and the Inez area (Station 143) between 29 and 35 fathoms on sandy bottoms with weed.

Sex and Size: The series consists of an adult male and ovigerous female which were taken in the same net, and a young male. Measurements gave the following results: Ovigerous female: Length 20, breadth 15, cheliped 21, ambulatories ca. 40.5, 30, 25 and ? mm. Adult male: Length 21.5, breadth 18, cheliped ca. 24, ambulatories ca. 47, 40, 32, and 29 mm. Young male: Length 12.6, breadth 9.7, cheliped ca. 16, ambulatories ca. 34, 25, 21, 19 mm.

Color in Life: Adults, reddish-brown, the chelae speckled with scarlet. Young male, pale buffy-yellow; chelae speckled with scarlet; bases of ambulatories tinged with pink.

Food: The stomachs of both the female and the young male contained bits of algae.

Breeding: The eggs carried by the female had already hatched, and many zoeas, each measuring about 2.3 mm. in length, were clustered around the anterior margin of the sternum.

Habits: All 3 specimens carried a few bits of algae held by the curved hairs, especially on the ambulatories.

Remarks: This species has been known previously from only 2 specimens, both young: namely, Stimpson's type of *Podonema vestita* (*Ann. Lyc.*

Nat. Hist. New York, vol. 10, 1871, p. 97) from Cape San Lucas, a female which measured 13.2 mm. in length and which is not extant; and Rathbun's type of *Podochela* (*Coryrhynchus*) *mexicana* (*Proc. U. S. Nat. Mus.*, vol. 16, 1893, p. 225), a male 10 mm. in length from the Gulf of California. The species were synonymized by Rathbun in 1925 (*Bull.* 129, *U. S. Nat. Mus.*, p. 42); to the rostrum the adjectives "short, rounded, . . . arcuate, thin" were applied, while the sternum and basal segments of the legs were described as "vermiculated. Sternal segments in the form of raised plates with sharp edges and separated by deep depressions."

The present specimens disagree with the description of these important characters in the following particulars: the rostrum, instead of being rounded, is bilobed in all the specimens, the lobes being conspicuous and unequal in the large male and female, and barely indicated by a slight, median emargination in the 12.6 mm. male; along the margins of the rostrum is a row of spinules which are clearly distinguishable even in the young specimen. The sternum is exactly as described except that the vermiculations are spinulous, especially in the large specimens.

In all other particulars given in the published descriptions, however, the young male, at least, of the present series agrees perfectly, and where the characteristics of the 2 adults differ from those of the young, the differences are merely intensifications of these characters obviously due to age or sex: The cardiac protuberances of the adults are higher and more compressed and scarcely continued forward (in the 12.6 mm. male the forward projection is evident, but not as pronounced as in Rathbun's 10 mm. specimen); the hepatic and pterygostomian lobes are relatively more developed; the outer margin of the basal antennal article is more conspicuously bi-lobed; and, finally the manus of the adult male is considerably, instead of slightly, swollen, the fingers gaping instead of meeting at the base. In view of these rather extensive, but obviously developmental, differences, it seems reasonable to attribute also to age the differences in the shape of the rostrum and the spinulation of both rostrum and sternum described in the preceding paragraph.

Details of the structure of the chelipeds in the adult male are as follows: Merus with a few small spinules on both outer and inner lower margins. Carpus with 7 or 8 small tubercles, the most anterior much the largest, scattered on the upper-outer surface. Manus considerably swollen, the outer surface covered with a dense, short pubescence and with some long, straight hairs (longest on the margins) and a few short, curved hairs, some of which form a longitudinal row; upper and lower margins each armed with an irregular row of very small spinules; 5 or 6 minute tubercles in a crooked line and several even smaller spinules on the nearly bare, inner surface of palm. Fingers slender, slightly gaping at base. Chelipeds of female slender, tubercles on inner surface of palm lacking.

Material: *Station* 136: D-30 (1 ♂). *Station* 143: D-1 (1 ♀, 1 ♂). Cat. Nos. 36,697, 36,869.

Inachoides laevis Stimpson, 1860.

General Range: Atlantic: from the west coast of Florida to Desteno, Brazil. Pacific: from Santa Inez Bay, Gulf of California, and Magdalena Bay, Lower California, to Panama. From 3 fathoms or less to 29 fathoms.

Local Distribution, Sex and Size: Two specimens, an ovigerous female and a male measuring 9.6 and 9.4 mm. in length respectively, were taken in the Inez area (Station 143) at a depth of 29 fathoms, the bottom being composed of crushed shell mud with a little weed.

Food: Traces of crustaceans, probably amphipods, were found in both stomachs.

Breeding: The female carried 362 eggs measuring .59 mm. in diameter,

Habits: Neither of the specimens was decorated.

Remarks: This variable species has not been recorded previously from the Gulf of California, and apparently has not been taken as deep as 29 fathoms. The present specimens have the sharp supraorbital tubercle described by Rathbun (1925 p. 61) as present on the Magdalena specimen, but the antennal ridges are coarsely denticulate in the male, and almost smooth in the female. There are about 15 good-sized tubercles on the inner surface of the manus of the cheliped in the male, and 3 or 4 large, along with a number of small ones on the outer surface. The manus of the female is almost smooth.

Material: *Station* 143: D-1 (1 ♀, 1 ♂). Cat. No. 36,876.

Erileptus spinosus Rathbun, 1893.

General Range: From Santa Rosa, California, to Abreojos Point, Lower California; Gulf of California. From 21 to 60 fathoms.

Local Distribution: A total of 14 specimens was taken from the Inez area (Station 147) in a single net at a depth of 60 fathoms, the bottom being composed of mud and crushed shell.

Size and Sex: The 10 females of the collection measured between 3.5 and 6.4 mm. in length, 9 of them being ovigerous. The single non-ovigerous female was immature and measured 4.6 mm. The 4 males were from 6 to 10 mm. long.

Food: Six stomachs all contained indeterminate animal remains and a few grains of sand.

Breeding: The 3.5 mm. female carried 21 eggs, a middle-sized specimen 46 and the largest 76. The diameters ranged from .43 to .48 mm.

Remarks: This species has not been reported before from the Gulf of California.

Material: *Station* 147: D-2 (10 ♀, 4 ♂). Cat. No. 36,837.

Eucinetops lucasii Stimpson, 1860.
(Plate II, Figures 5, 6).

General Range: Gulf of California and Cape San Lucas, Lower California. Shallow water.

Local Distribution, Sex and Size: Two males, each measuring 6.9 mm. in length, were taken in the Inez area (Station 144) at a depth of 1 fathom on a sandy bottom with weed.

Color in Alcohol: The chelipeds, and, to a lesser extent, the ambulatories were conspicuously banded and marbled.

Habits: The specimens were fairly well covered with algae.

Remarks: This is the third time this species has been taken, neither of the other specimens being extant. Our two males agree well with the descriptions (accepting Rathbun's synonymy given in 1925, p. 85) except for the following details: the rostral horns of the more developed specimen are distinctly but abruptly pointed or spined, similar to those of *E. panamensis*, while the rostrum itself and the horns are longer; the younger male on the other hand has one horn blunt, possibly broken, and the other pointed, although not so sharply as in the older specimen. The eye-stalks, however, agree well with Lockington's description of his 8-mm. specimen, each stalk being about as long as the distance between the bases of the eyes; when in a natural position, pointing obliquely outward, each extends almost twice the length of the postocular spine beyond its tip, measuring the length of the spine along its anterior margin. This character alone separates the species from *E. panamensis*.

In addition to the 3 tubercles in a transverse line on the gastric region mentioned in Stimpson's description of the female, the carapaces of the present specimens are ornamented with 4 spines and tubercles and a number of small lumps on each branchial region, arranged as follows: a distinct spine, directed upward, slightly above the postero-lateral curve of the carapace, a smaller spine or tubercle in front of this, and 2 tubercles in a transverse line between it and the cardiac region; finally, there is a prominent oblong swelling on the summit of the branchial region and a few scattered, minute tubercles.

In both specimens the merus of the chelipeds is nearly smooth, slightly lumpy at most, not tuberculate as in Lockington's older specimen, while the tooth on the inner side of the movable finger near its base is also lacking. Both of these are doubtless age characters. It is of interest that the cheliped of one of the present specimens is considerably longer and thicker than that of the other crab of the same length.

Due to the small size of these specimens, a neotype is not proposed.

Material: *Station* 144: D-1 (2 ♂). Cat. No. 36,838.

Euprognatha bifida Rathbun, 1893.

General Range: Both coasts of Lower California. From 3 feet to 45 fathoms.

Local Distribution: A total of 59 specimens was taken from Magdalena Bay, San Lucas Bay (Station 135), Gorda Banks (Station 150), Arena Bank (Station 136) and the Inez area (Station 142) between 3 feet and 45 fathoms, usually on sandy bottoms, or on bottoms of sand and crushed shell.

Sex and Size: Males, which measured 5 to 10 mm. in length, were almost 3 times as numerous as the females, which measured from 5.1 to 7.9 mm. Ovigerous females ranged from 5.1 to 7.4 mm.

Color in Life: Pale gray.

Food: The specimen from Magdalena Bay contained an amphipod; all the other stomachs examined, numbering a dozen from various dredges, contained grains of sand mingled with finely digested algae.

Breeding: Of the 16 females taken, 14 were ovigerous. The eggs, measuring .43 mm. in diameter, were difficult to count accurately since they dissolved at a touch; the usual number, however (based on 6 counts) was about 70.

Habits: In 2 widely separated localities, namely Arena Bank and the Inez area, these little gray crabs were found clinging tightly to worm tubes which they exactly matched in color.

Remarks: This species has not been taken previously in water less than 18 fathoms or more than 40 fathoms in depth. In the specimens from the San Lucas region, the tubercles of both sexes are blunter and less conspicuous than in those from the other regions.

Material: *Shore of Magdalena Bay*: (1 ♀). *Station* 135: D-9 to D-26 incl. (7 ♀, 13 ♂). *Station* 136: D-1 (1 ♀), D-5 (1 ♂), D-6 (1 ♂), D-13 (1 ♂), D-26 (1 ♀, 1 ♂), D-30 (1 ♀, 1 ♂). *Station* 142: D-1 (2 ♂), D-2 (4 ♀, 22 ♂). *Station* 150: D-8 (1 ♀, 1 ♂). Cat. Nos. 36,701, 36,702, 36,839, 36,840, 36,877.

Collodes tenuirostris Rathbun, 1893.

General Range: Western coast of Lower California; Gulf of California. From 33 to 145 fathoms.

Local Distribution: 3 females, from 14 to 19 mm. in length, were taken from the Inez area (Stations 142 and 146) between 33 and 35 fathoms on bottoms composed of mud and crushed shell.

Food: The stomachs of 2 specimens contained algae.

Breeding: A single specimen was ovigerous. It measured 15.5 mm. in length by 13 in breadth and carried 246 eggs, .51 mm. in diameter.

Material: *Station* 142: D-2 (2 ♀). *Station* 146: D-1 (1 ♀). Cat. Nos. 36,841, 36,842.

Collodes tumidus Rathbun, 1898.

General Range: Western coast of Lower California; southern part of Gulf of California. From 10 to 35 fathoms.

Local Distribution: A single young male, measuring 6.6 mm. in length, was taken on Arena Bank (Station 136 D-30; Cat. No. 36,703) at a depth of 35 fathoms on coarse sand with weed.

Remarks: This specimen is the fourth ever recorded, and increases the recorded depth from 12 to 35 fathoms. The chelipeds are not yet inflated.

Pyromaia tuberculata (Lockington), 1877.

General Range: From Monterey Bay, California, to the Bay of Panama. From 3½ to 66 fathoms.

Local Distribution: 4 specimens were taken from the Inez area (Station 143) between 25 and 35 fathoms on bottoms ranging from soft mud with shell to firm sand, with or without weed.

Sex and Size: The single female, ovigerous, measured 14 mm. in length and 11 in breadth; the 3 males were from 9.9 mm. long by 7.2 mm. wide to 12.7 mm. long and 9.4 mm. wide.

Food: The 2 stomachs examined contained bottom detritus including Foraminifera.

Breeding: The female carried 387 eggs measuring .35 mm. in diameter.

Remarks: All of the specimens were typical representatives of the "variety A" designated by Rathbun (1925, p. 136), which includes specimens from the Lower California region and is characterized by the presence of 2 well developed gastric tubercles.

In both the smallest and largest male the manus of the cheliped was considerably swollen, while in the middle-sized crab it was scarcely inflated at all.

Material: *Station* 143: D-1 (1 ♂), D-2 (1 ♀), D-3 (1 ♂), D-4 (1 ♂). Cat. No. 36,843.

Dasygyius depressus (Bell), 1835.

General Range: Gulf of California; Galápagos Islands. From 6 to 60 fathoms.

Local Distribution: A total of 363 specimens was taken from Gorda Banks (Station 150), Arena Bank (Station 136) and the Inez area (Stations 142, 143, 146 and 147) between 29 and 60 fathoms, usually on mud bottoms; in 4 out of the 19 dredges in which the species occurred, however, the bottom was sandy or rocky.

Sex and Size: Females, which measured 10.2 to 19 mm. in length, were almost twice as numerous as the males, which measured from 8.4 to 27.5 mm. Ovigerous females ranged from 17.5 to 19 mm. The chelipeds of the males were fully developed in specimens 22 mm. in length and over. Detailed measurements of the 2 largest specimens in the collection were as follows: Ovigerous female, length of carapace 19, breadth of carapace 21, length of cheliped 18.5 mm. Male, length of carapace 24.5, breadth of carapace 27.5, length of cheliped 32 mm.

Color in Life: Entire crab pinkish with olive-gray pubescence, except for manus and dactyls of cheliped, which were pure white. Eggs coral-red.

Food: An examination of 17 stomachs gave the following results: 11 held sand, usually almost filling stomach; 2 (a male and female from Station 142 D-3) contained remains of the oxystomatous crab, *Randallia americana;* 1 held unidentifiable crustacean remains; 3 were entirely empty.

Breeding: Over four-fifths of all females were ovigerous. The eggs measured from .43 to .48 mm. in diameter. Counts on six specimens gave totals ranging from 205 to 230.

Habits: The viability of these crabs seems very low: all of the numerous specimens taken were either dead when the net came up or nearly so, dying soon after. The movements of even those in the best condition were invariably sluggish.

Remarks: This species has not hitherto been reported below 26.5 fathoms.

Material: *Station* 136: D-1 (1 ♂), D-4 (26 ♀ and ♂), D-5 (1 ♂), D-7 (3 ♀, 3 ♂), D-10 (3 ♂), D-13 (1 ♂), D-14 (32 ♀, 4 ♂), D-15 (42 ♀, 11 ♂), D-16 (10 ♀, 15 ♂), D-17 (5 ♀, 6 ♂), D-18 (1 ♀), D-23 (1 ♂). *Station* 142: D-2 (1 ♂), D-3 (3 ♀, 2 ♂). *Station* 143: D-1 (43 ♀ and ♂), D-2 (79 ♀ and ♂), D-3 (33 ♀ and ♂), D-4 (20 ♀ and ♂), D-5 (13 ♀ and ♂). *Station* 146: D-1 (2 ♂). *Station* 147: D-2 (1 ♂). *Station* 150: D-8 (1 ♀).

Of these 363 specimens, 35 are preserved (Cat. Nos. 36,704, 36,844, 36,845, 36,846, 36,878).

Subfamily Acanthonychinae.

Epialtus minimus Lockington, 1877.

(Plate II, Figure 7).

General Range: Gulf of California. From low tide to 2½ fathoms.

Local Distribution: A total of 15 specimens was taken from the San Lúcas area (Station 144) between the low-tide mark and 2½ fathoms on sandy bottom with weed and stones.

Sex and Size: The 9 females ranged in length from 8.2 to 14.5 mm.; the 7 males from 6 to 18 mm. Ovigerous females measured from 9.4 to 14.5 mm.

Color in Life: Creamy to ochraceous yellow, the chelipeds and ventral surface sometimes spotted or blotched with brown.

Food: All stomachs examined were crammed with algae.

Breeding: Of the 9 females, 7 were ovigerous. The eggs measured .48 mm. in diameter. Four counts gave totals ranging from 145 to 680, the number depending, as usual, directly on the size of the crab.

Habits: Bryozoans were attached to one crab and bits of sponge to another; the remainder were not decorated.

Remarks: The following sexual differences are apparent in the present series: In the females the pre-hepatic length is much shorter than in the males, being contained up to more than 3 times in the post-hepatic length, instead of almost, or more than equalling it. (In the present series, however, all of the males have the pre-hepatic length slightly shorter than the post-hepatic, whereas in some of Rathbun's specimens it was equal. See Rathbun, 1925, p. 155). Also, the females have the anterior margin of the hepatic lobe irregularly scalloped, instead of with a single low tooth, and the supra-orbital tooth is better developed than in the male. It will be seen from the photograph that, even in addition to sexual differences, the species is very variable.

Material: *Station* 144: D-1 (4 ♀, 3 ♂), D-2 (2 ♀, 1 ♂), D-3 (1 ♀, 2 ♂). *Shore of Santa Inez Bay*: (1 ♀, 1 ♂). Cat. Nos. 36,847, 36,848.

Sphenocarcinus agassizi Rathbun, 1893.

General Range: From the Gulf of California to Panama. From 14 to 71 fathoms.

Local Distribution: A total of 24 specimens was taken from Gorda Banks (Station 150) and Arena Bank (Station 136) between 40 and 70 fathoms, almost always on muddy bottoms. In 2 of the 11 dredges in which it was taken, however, the bottom was sandy.

Sex and Size: The 21 females measured from 13.5 to 44 mm. in length, the 3 males from 14.5 to 58 mm. The smallest ovigerous female measured 29.5 mm. Detailed measurements of the two largest specimens in the collection were as follows: Ovigerous female, length 44, breadth 30, length of cheliped 32 mm. Male, length 58, breadth 36, length of cheliped 75 mm.

Color in Life: General color olive brown, usually darkest posteriorly. In the adult males the entire cheliped, with the exception of the dorso-exterior surface of the merus, was bright rose red, sometimes speckled with black, while the projecting parts of the ventral surface were similarly colored. Large females occasionally also had a tinge of pink ventrally. Eggs bright scarlet or grenadine orange to mulberry red, ova of the latter shade being almost ready to hatch.

Food: 7 stomachs contained only slight traces of mud; while 1 held the body and operculum of a small snail.

Breeding: Ovigerous specimens numbered two-thirds of all the females. The eggs measured .54 mm. in diameter. A specimen 29.5 mm. long carried 315 eggs, one of 33.5 mm. 850 eggs, and one of 44 mm. 1,650 eggs.

Habits: These crabs had very little vitality. The majority were dead when the dredge reached the surface, while those that were still alive died almost immediately, even when placed at once in aquariums.

Material: *Station* 136: D-2 (3 ♀), D-8 (3 ♀, 1 ♂), D-9 (1 ♀), D-16 (1 ♂), D-18 (2 ♀), D-20 (2 ♀), D-22 (6 ♀), D-23 (1 ♀), D-24 (1 ♀), D-26 (1 ♀). *Station* 150: D-4 (1 ♀, 1 ♂). Cat. Nos. 36,705, 36,706.

Subfamily Pisinae.

Rochinia vesicularis (Rathbun), 1907.

(Plate III, Figures 8, 9).

General Range: Off Galápagos Islands; southern part of Gulf of California. From 40 to 300 fathoms.

Local Distribution: 3 specimens were taken from Gorda Banks (Station 150) in a single net between 40 and 100 fathoms on a rocky bottom.

Sex and Size: The young female measured more than 13 mm. in length by 9 in breadth; the 2 males each over 11.5 by 8 and over 19.5 by 15 mm., respectively. The tips of the rostrum were broken off in every specimen.

Remarks: This species has been known previously only from 3 specimens, including the male holotype 20.7 mm. long, all taken off the Galápagos Islands at a depth of 300 fathoms. The present trio of specimens differs from the published description and figures in the relatively greater breadth of the carapace and in the shorter legs. The number and arrangement of all the spines, however—including the 2 very characteristic spines on the basal antennal article and the spine on the lower margin of the orbit outside the antennal article—as well as the presence of spherical vesicles on the carapace, indicate that the differences in proportions are due only to the youth of the present specimens. As has already been stated, the tips of the rostral horns are broken in all 3 specimens.

Material: *Station* 150: D-5 (1 ♀, 2 ♂). Cat. No. 36,707.

?*Herbstia tumida* (Stimpson), 1871.

General Range: Gulf of California and Manzanillo, Mexico.

Local Distribution: 3 juvenile specimens (Cat. No. 36,757) each measuring about 5.5 mm. in length, were taken off Arena Bank (Station 136 D-33) in coral (*Pocillopora ligulata*) at a depth of 2½ fathoms.

Remarks: This species has been known previously from only 2 specimens, Stimpson's non-extant type from Manzanillo, and a specimen in the American Museum of Natural History from the Gulf of California, 13.5 mm. in length. Allowing for the difference in age, the present series of young specimens agrees well with the descriptions, except for the relative flatness of the carapace and the absence of a small tooth at the insertion of the first movable article of the antenna. Additional material is needed for an adequate knowledge of the characters of this and closely related species.

Lissa aurivilliusi Rathbun, 1898.

General Range: West coast of Lower California; southern part of Gulf of California; Galápagos Islands. To a depth of 35 fathoms.

Local Distribution: A single male (Cat. No. 36,708), 11 mm. in length, was taken from Arena Bank (Station 136 D-30) at a depth of 35 fathoms on a sandy bottom with weed.

Habits: The carapace was decorated with bits of sea urchin test and fragments of sponge.

Remarks: This is the first time this species has been taken within the Gulf.

Lissa tuberosa Rathbun, 1898.

General Range: Southern part of Gulf of California. From 7 to 30 fathoms.

Local Distribution: A single non-ovigerous female (Cat. No. 36,709), 12 mm. in length, was taken from Gorda Banks (Station 150 D-7) at a depth of 20 to 30 fathoms on a sandy bottom.

Remarks: The teeth at the anterior angles of the front are slightly more, not less, advanced than the submedian lobes. In all other respects, however, the specimen agrees perfectly with the description.

This species has not been previously reported below 10 fathoms.

Subfamily Majinae.

Thoe sulcata Stimpson, 1860.

General Range: West coast of Mexico from Tepoca Bay in the Gulf of California to the State of Oaxaca. From low tide to at least 2½ fathoms.

Local Distribution: A single male (Cat. No. 36,758), 7.3 mm. in length, was taken from a piece of coral (*Pocillopora ligulata*) brought up close to Arena Bank (Station 136) from a depth of 2½ fathoms.

Pitho picteti (Saussure), 1853.

General Range: West coast of Mexico including the Gulf of California; Central America. From 3 feet to 45 fathoms.

Local Distribution: A single male (Cat. No. 36,849), 15.5 mm. in length, was taken under a stone in 3 feet of water on the shore of Magdalena Bay.

Habits: The crab was well decorated with large grains of sand and bits of shell and weed.

Pitho sexdentata Bell, 1836.

General Range: Gulf of California; Cape San Lucas; Galápagos Islands. Shallow water.

Local Distribution: A single male (Cat. No. 36,867), 10 mm. in length, was taken off Santa Inez Point on some floating weed.

Habits: The crab was decorated with large grains of sand and bits of weed.

Remarks: This species has not been recorded previously from north of Cape San Lucas.

Mithrax (*Mithrax*) *mexicanus* Glassell, 1936.
(Plate III, Figures 10, 11).

General Range: Gulf of California. At 50 fathoms.

Local Distribution: A single specimen, the male holotype (Cat. No. 36,712), was taken on Arena Bank (Station 136 D-27) at a depth of 50 fathoms on a bottom composed of sand and rock.

Remarks: For a description of this species, see *Zoologica*, XXI, No. 17, p. 213. The holotype is deposited in the collections of the Department of Tropical Research of the New York Zoological Society.

Mithrax (*Mithrax*) *sinensis* Rathbun, 1892.

General Range: Gulf of California. From 7 to 30 fathoms.

Local Distribution: A single young female (Cat. No. 36,710), 7 mm. long, was taken on Gorda Banks (Station 150 D-7) between 20 and 30 fathoms on a sandy bottom.

Remarks: This species has not been recorded previously below 17 fathoms.

Mithrax (*Mithrax*) *spinipes* (Bell), 1836.

General Range: From the Gulf of California to Ecuador and the Galápagos Islands. From 2½ to 45 fathoms.

Local Distribution: 2 specimens were taken from Arena Bank (Station 136) in 2½ and 45 fathoms of water, respectively. The shallow water specimen was found in a piece of coral (*Pocillopora ligulata*), while the deep water crab was from a muddy bottom.

Sex and Size: The specimens were male and young female, measuring 10.1 and 17.5 mm. respectively, the larger specimen having been taken in deep water.

Color in Life: Carapace and chelipeds violet pink; ambulatories faintly pink above; ventral surface grayish-white. (Described from the female specimen).

Remarks: The female from deep water differs from typical members of the species in having a single good-sized tubercle instead of two small ones on the anterior mesogastric region, in which respect it resembles *M. acuticornis*. Mr. Steve A. Glassell, who has kindly examined our specimen, says he finds the species to be variable in this character.

This species has been recorded previously only between 6 and 33 fathoms.

Material: *Station* 136: D-1 (1 ♀), D-33 (1 ♂). Cat. Nos. 36,711 and 36,760.

Mithrax (*Mithrax*) *tuberculatus* Stimpson, 1860.

General Range: From Arena Bank in the Gulf of California to Panama.

Local Distribution: 4 specimens (Cat. No. 36,759) were taken from

a piece of coral (*Pocillopora ligulata*) which was brought up off Arena Bank (Station 136 D-33) from a depth of 2½ fathoms.

Sex and Size: The 3 females were all ovigerous and measured from 15 to 17.5 mm. in length; the single male measured 24 mm.

Color in Life: Crimson to maroon, mottled ventrally with a varying amount of white. Chelipeds either pale cream except for crimson dactyls or mottled crimson and white, or entirely crimson. The color was deepest in the male.

Food: 2 stomachs contained large quantities of algae mixed with small amounts of coral detritus, bits of sponge and unidentifiable animal matter.

Breeding: The 3 females each carried from 375 to 525 eggs measuring from .5 to .6 mm. in diameter.

Habits: Bryozoans were attached to the carapaces of 2 specimens and a worm tube to a third.

Remarks: In 2 specimens there is a small accessory spine on one or both sides located in front of the last anterolateral spine.

This species has not been recorded previously north of Cape San Lucas.

Mithrax (*Mithraculus*) *areolatus* (Lockington), 1877.

General Range: San Diego, California; Gulf of California; Bay of Panama and Pearl Islands. Shallow water.

Local Distribution: 3 males (Cat. No. 36,866), measuring from 3.8 to 7 mm. in length, were taken from a piece of coral (*Pocillopora ligulata*), which was brought up off Arena Bank (Station 136 D-33) from a depth of 2½ fathoms.

Teleophrys cristulipes Stimpson, 1860.

General Range: From Arena Bank in the Gulf of California to Panama; Galápagos Islands.

Local Distribution: 9 specimens (Cat. No. 36,865) were taken from a piece of coral (*Pocillopora ligulata*) which was brought up off Arena Bank (Station 136 D-33) from a depth of 2½ fathoms.

Sex and Size: The 6 females measured from 4.3 to 6.1 mm. in length, the 3 males from 4.6 to 8.5. Ovigerous females were 6 mm. long. All of the younger specimens were about as long as wide or a little longer, instead of being slightly wider than long.

Breeding: Of the 6 females, 3 were ovigerous. The eggs measured .28 mm. in diameter and numbered 170 in one case. In the others some of the zoeas had already hatched.

Stenocionops beebei Glassell, 1936.
(Plate IV, Figures 13-15).

General Range: Gulf of California. From 35 to 45 fathoms.

Local Distribution: 7 specimens were taken on Arena Bank (Station 136) between 35 and 45 fathoms on sandy and muddy bottoms.

Sex and Size: The series contains a single female, non-ovigerous, 56 mm. in length (the holotype), and 6 males measuring from 9.5 to 20 mm. in length (including the male paratype).

Color in Life: The holotype was dull pink.

Habits: All of the specimens were decorated with tiny sponges, hydroids and algae, the smaller specimens to a greater extent than the larger ones.

Remarks: For a description of this species, see *Zoologica*, XXI, No. 17,

p. 214. Mr. Steve Glassell, the author of the species, has examined the 5 small specimens in the collection which were isolated after the publication of the type description, and has designated them as metatypes. The holotype is deposited in the collections of the Department of Tropical Research of the New York Zoological Society, while the paratype and 3 metatypes are in those of the San Diego Society of Natural History.

Material: *Station* 136: D-13 (1 ♂), D-23 (1 ♀, 3 ♂), D-30 (2 ♂). Cat. Nos. 36,714 (holotype) and 36,928.

Stenocionops contigua (Rathbun), 1892.

General Range: Magdalena Bay, Lower California; Gulf of California. To a depth of 30 fathoms.

Local Distribution: A single young male (Cat. No. 36,850), 20.5 mm. in length, was taken in the Inez area (Station 142 D-1) at a depth of 30 fathoms on a bottom composed of coarse shelly sand with weed.

Habits: The crab was decorated sparsely with bits of weed and grains of sand.

Remarks: This species has not been recorded previously from below 21 fathoms.

Stenocionops macdonaldi (Rathbun), 1892.

General Range: Gulf of California; Bay of Panama. From 33 to 145 fathoms.

Local Distribution: A total of 13 specimens was taken on Arena Bank (Station 136) between 45 and 55 fathoms on muddy bottoms.

Sex and Size: The 12 females measured 61.5 to 81.5 mm. in length, the single male 37.5 mm. Ovigerous females ranged from 69.5 mm.

Color: Pink with olive brown pubescence. Chelae dark brown.

Food: Each of the 3 stomachs examined contained a little weed and a considerable amount of indeterminate animal matter.

Breeding: Several of the females were ovigerous. The eggs of an 81.5 mm. specimen measured .59 mm. in diameter and numbered about 36,000.

Remarks: This species has been known previously only from 7 specimens taken by the *Albatross*. The present series differs from the description in that the outer margins of the rostral horns tend to diverge widely instead of converge slightly, but they show variation in this respect even among themselves. The length of the rostrum of the larger specimens is contained 9 to 10 times in the total length, not 12 as in Rathbun's slightly larger (93 mm.) male type, while that of our 37.5 mm. young male is contained only 7 times in the length—i. e., it approximates the relative size of the rostrum in *S. triangulata* (Rathbun). In the latter species, which is known only from specimens up to 30 mm. long, the rostral length is contained 6 times in the length of the crab.

This young male of the present collection, although clearly referable to *S. macdonaldi* and not to *S. triangulata*, nevertheless lends further support to Rathbun's suggestion (1925, p. 461 ff.) that the two species are synonymous. While its hepatic spines are double on one side and triple on the other, as in typical *S. macdonaldi*, still the subsidiary spines are very small (they are absent in *S. triangulata*). Again, the hepatic region, instead of bulging prominently as in *S. macdonaldi*, protrudes only slightly more than in *S. triangulata;* in even our largest specimen the hepatic regions do not project quite as much as in Rathbun's figure of the slightly larger type of *S. macdonaldi*, so that it is evident that this characteristic develops with growth. The relatively greater length of the rostrum is, of course, typical of the young of many crabs. Finally, the range of *S. triangulata* is

similar to that of *S. macdonaldi*. Nevertheless, a still smaller intermediary specimen should be secured before the two species are actually synonymized.

Material: *Station* 136: D-7 (3 ♀), D-9 (1 ♀), D-17 (8 ♀), D-22 (1 ♂). Of these specimens 4 are preserved (Cat. No. 36,713).

Macrocoeloma villosum (Bell), 1836.
(Plate III, Figure 12).

General Range: From Santa Inez Bay in the Gulf of California to Ecuador. To a depth of at least 11 fathoms.

Local Distribution: A single young male (Cat. No. 36,352), 9.6 mm. in length, was taken from weed floating near Santa Inez Point.

Remarks: This specimen differs from the descriptions in having the postero-lateral spines directed very slightly backward instead of forward, while the pits between the protuberances of the carapace are only slightly vermiculated. All the specimens previously known, however, were over an inch in length—3 times the size of the present crab.

This species has not been recorded previously north of Cape San Lucas.

Microphrys branchialis Rathbun, 1898.

General Range: From Abreojos Point, Lower California, to the Gulf of California. From 12 to 48 fathoms.

Local Distribution: 2 specimens were taken from Arena Bank (Station 136) at 35 and 40 fathoms on bottoms composed of mud and of coarse sand with weed, respectively.

Sex and Size: The non-ovigerous female measured 10.1 mm. in length, the male 8.4 mm.

Color: The female, taken on the muddy bottom, was pinkish-olive with the manus and dactyls of the chelipeds pink.

Habits: In contrast with *M. platysoma*, this species is provided with few curved hairs, and our specimens carried no decoration whatever of weed or sand.

Material: *Station* 136: D-23 (1 ♀), D-30 (1 ♂). Cat. No. 36,715.

Microphrys platysoma (Stimpson), 1860.

General Range: From the western coast of Lower California and the Gulf of California to Panama. From low tide to at least 4½ fathoms.

Local Distribution: A total of 4 specimens was taken in the Inez area (Station 144 and the shore of Santa Inez Bay) between low tide and 2½ fathoms on sandy bottoms with weed.

Sex and Size: The 3 females measured 9, 12.4 (ovigerous) and 14 mm. in length, respectively; the single male 13.2 mm.

Color in Life: Our specimens agreed well with those described in Lockington's notes (*Proc. Calif. Acad. Sci.*, vol. 7, 1876 [1877], p. 66 [4]), but there was considerable variation: Carapace plain tan to reddish-brown; chelipeds creamy white above mottled with pink, or red marbled with white, a band of bright red usually present across base of fingers; underparts and ambulatories pale cream, sometimes mottled with pink or red.

Food: The stomach of the largest female held several amphipods, while that of the ovigerous specimen was crammed with seaweed.

Breeding: There was a total of 315 eggs, .54 mm. in diameter.

Habits: Each specimen was well decorated with grains of sand and bits of weed held in place chiefly by the curved hairs of carapace and appendages.

Material: *Station* 144: D-2 (2 ♀, 1 ♂). *Shore of Santa Inez Bay*: (1 ♀). Cat. No. 36,851.

Tyche lamellifrons Bell, 1836.

General Range: From the Gulf of California to Panama on sandy bottoms. To a depth of 29 fathoms.

Local Distribution: 2 specimens were taken from the Inez area (Stations 143 and 144) on sandy bottoms with weed at depths of 29 and 2½ fathoms respectively.

Sex and Size: The non-ovigerous female measured 24 mm. in length, the male 18.5 mm.

Color in Life: Although Bell (*Proc. Zool. Soc. London,* vol. 3, 1835 [1836], p. 173) recorded the color as dull, uniform brown which was paler beneath, both of our specimens were tinged strongly with pink.

Habits: Both specimens were covered with sponges and bristled with algae of several kinds, so that their outlines were entirely concealed. Even the ambulatories were decorated, and each specimen held between the rostral horns an especially large frond of seaweed.

Remarks: The present specimens increase the known depth range from 10 to 29 fathoms.

Material: *Station* 143: D-1 (1 ♂). Station 144: D-2 (1 ♀). Cat. No. 36,852.

Family Parthenopidae.

Parthenope (Platylambrus) exilipes (Rathbun), 1893.

General Range: From the west coast of Lower California and the southern part of the Gulf of California to Panama and the Galápagos Islands. From 20 to 80 fathoms.

Local Distribution: A total of 26 specimens was taken from Gorda Banks (Station 150) and Arena Bank (Station 136) between 20 and 75 fathoms on muddy and sandy bottoms.

Sex and Size: The 9 females measured from 17 to 24 mm. in length, the largest being ovigerous. The 17 males ranged from 7 to 30 mm.

Color in Life: Males: Carapace and chelipeds light yellow brown to olive brown marked with chestnut and light orange; ventral side of chelipeds salmon pink or orange with a violet spot at joint between merus and carpus; tips of dactyls white washed with red violet; ambulatories white banded with maroon or chestnut and tipped with grayish-brown. Female: Carapace usually darker and more reddish than in male. Eggs coral red.

Food: A 29.5 mm. male had eaten a very small crab of the same species; a second stomach held traces of another crab (species indeterminable); a third held a minute holothurian. The remainder of the 6 stomachs examined were empty.

Breeding: The single ovigerous female carried at least 8,000 eggs, almost all of which had already hatched, the shells being still attached to the pleopods. The unhatched eggs measured .32 mm. in diameter.

Habits: A specimen was kept alive in an aquarium for several days. It spent almost the entire time buried in the mud with only the eyes projecting.

Remarks: The tubercles of males were sharper than those of females, while the young specimens had the sharpest ones of all. This species has not been reported previously at less than 31 fathoms.

Material: *Station* 136: D-8 (1 ♀), D-18 (1 ♀), D-20 (2 ♀, 1♂), D-21 (1 ♀, 2 ♂), D-24 (1 ♂), D-26 (1 ♀, 1 ♂), D-27 (3 ♀, 1 ♂). *Station* 150: D-3

(1 ♂), D-4 (2 ♂), D-8 (5 ♂), D-9 (1 ♂), D-16 (2 ♂). Of these specimens 13 are preserved (Cat. Nos. 36,716 and 36,717).

Parthenope (*Pseudolambrus*) *excavata* (Stimpson), 1874.
(Plate V, Figures 16, 17).

General Range: From Santa Inez Bay in the Gulf of California to Panama.

Local Distribution: A single male (Cat. No. 36,853) was taken in the Inez area (Station 143 D-1) at a depth of 29 fathoms on a sandy bottom with weed.

Sex and Size: The measurements of this male are as follows: length 15, breadth 18, cheliped 28, right propodus 14.2, right manus 12.2 mm.

Remarks: Both of the specimens previously taken, the non-extant type from Manzanillo and the specimen from Panama, were over an inch long and both were females. The present young male agrees with the descriptions perfectly in general shape and appearance and in the tuberculation of the chelipeds. It disagrees markedly, however, in having long, sharp supraorbital and branchial spines instead of low tubercles. Also, there are traces of another pair of long spines on the anterior mesogastric region and of a single spine on the cardiac prominence, all three being obviously broken off, but resembling low tubercles in their present condition. Nevertheless, since tubercles are normally sharper and more spine-like in young males of this genus than in older specimens of the opposite sex, and since it is possible that some of the spines of the previously recorded females were broken off and hence resembled tubercles, just as they do in the present case, it appears that the creation of a new species with the present specimen as holotype would be unjustified.

Parthenope (*Pseudolambrus*) *triangula* (Stimpson), 1860.
(Plate V, Figure 18).

General Range: Known only from Cape San Lucas, Lower California.

Local Distribution: A single male (Cat. No. 36,718), measuring 8.4 mm. in length by 10 mm. in breadth, was taken in San Lucas Bay (Station 135 D-20) at a depth of 3 fathoms on a sandy bottom.

Remarks: This species was previously known only from the non-extant type specimen, a female measuring 14 mm. in length by 17.5 mm. in breadth, which was also taken at San Lucas. Our specimen differs from it in having the antero-branchial region slightly more prominent, so as almost to form an angle as in *P.* (*P.*) *excavata*. Due to its small size, this male is not proposed as a neotype.

Mesorhoea bellii (A. Milne Edwards), 1878.

General Range: From Abreojos Point on the western coast of Lower California and from the Gulf of California to Panama Bay. From 9½ to 71 fathoms.

Local Distribution: A total of 19 specimens was taken from San Lucas Bay (Station 135), Arena Bank (Station 136) and the Inez area (Stations 141, 142 and 143) between 13 and 45 fathoms on sandy or muddy (usually sandy mud) bottoms.

Sex and Size: The 12 females measured between 9.7 and 14 mm. in length (2 specimens, each 14 mm. long, were ovigerous). The 7 males ranged from 7.5 to 14.5 mm.

Food: Of the 6 stomachs examined, 3 contained bottom detritus, 1 a worm and 2 were empty.

Breeding: The eggs were .27 mm. in diameter and numbered about 2,600 on each of the ovigerous females.

Remarks: As in the analogous Atlantic species, *M. sexspinosa*, there is considerable variation in the size of the teeth at the branchial angle of the carapace and on the posterior margin. The length of the rostral lobe is also variable. In general, old males have the longest spines and teeth and the smallest rostral lobes, while the opposite is true of young females.

Material: *Station* 135: D-11 (1 ♂), D-26 (1 ♀). *Station* 136: D-14 (2 ♀). *Station* 141: D-4 (1 ♀). *Station* 142: D-2 (1 ♀), D-3 (1 ♀). *Station* 143: D-2 (1 ♀, 1 ♂), D-3 (2 ♀, 3 ♂), D-4 (1 ♀), D-5 (2 ♀, 2 ♂). Cat. Nos. 36,719, 36,720, 36,854, 36,855, 36,856.

Superfamily Brachyrhyncha.

Family Portunidae.

Ovalipes punctatus (de Haan), 1833.

General Range: Cape San Lucas, Lower California; Peru; Chile; Uruguay; Argentina; South Africa; Japan; China; Australia; New Zealand.

Local Distribution: The manus (Cat. No. 36,924) of a cheliped was taken from the stomach of a long-snouted shark, *Carcharias velox*, April 3, 1936, in San Lucas Bay (Station 135). This is the first record of the crab's occurrence on the eastern Pacific coast north of Peru.

Portunus (Achelous) iridescens (Rathbun), 1893.

General Range: West coast of lower California; Gulf of California. From 18 to 112 fathoms.

Local Distribution: A total of 447 specimens was taken off Cape San Lucas (Station 151), on Arena Bank (Station 136) and in the Inez area (Stations 142, 143, 146 and 147) between 30 and 60 fathoms. The great majority occurred on mud bottoms, with only a few on sand, shelly or rocky bottoms with weed.

Sex and Size: The 264 males, half again as numerous as the females, measured between 6.3 and 26 mm. in length. Females ranged from 13.5 to 26.5 mm., with ovigerous specimens from 17 to 25 mm. Detailed measurements of the 2 largest specimens in the collection are as follows: Female, length 26, breadth 52, breadth in front of lateral spines 38, fronto-orbital breadth 19.5, length of cheliped 62, length of carpal spine 12.5 mm. Male, length 26, breadth 53, breadth in front of lateral spine 39, fronto-orbital breadth 19, length of cheliped 80, length of carpal spine 32.

Color in Life: Carapace olive gray, the ridges and prominences being chestnut or maroon; lateral spines sometimes yellow orange, always tipped with white; underparts whitish; eyes olive green; palps of outer maxillipeds opalescent; chelipeds paler than carapace—cream-colored to light sienna, the ridges colored as on the carapace; short spines of chelipeds also maroon tipped with white and orange; carpal spines usually reddish-orange tipped with white, the fringe of hair being pale Indian red; ambulatories whitish spotted with dull yellow brown, barred with maroon and tipped with light orange red; swimmerets each tipped with a characteristic reddish-purple ocellus with a white center. In the smallest specimens (up to 14 mm. in length) the general color is very pale, but even in the youngest the ocelli are visible. The chelipeds of adult males are much redder than those of other specimens. Eggs coral red.

Food: 12 stomachs contained material distributed as follows: Stomachs with sand and algae, 2; with sand alone, 1; with pebbles, bits of shell and minute snails, 1; with amphipods, 1; with worm, 1; with echinoderm (probably sea-urchin), 1; empty, 5.

Breeding: About three-fifths of the females were ovigerous. The eggs measured .32 mm. in diameter. Three counts gave totals ranging from about 13,000 (on a female measuring 17 mm. in length) to about 21,500 (on a 23 mm. specimen).

Habits: In an aquarium a specimen lived several days, remaining buried under a thin film of mud.

Remarks: In the adult males of the present collection, the carpal spine did not quite reach the tip of the manus.

Material: *Station* 136: D-2 (1 ♂), D-4 (20 ♀ and ♂), D-7 (17 ♀, 8 ♂), D-8 (5 ♀, 1 ♂), D-9 (9 ♀, 9 ♂), D-10 (5 ♀, 9 ♂), D-13 (1 ♂), D-14 (3 ♀, 9 ♂), D-15 (9 ♀, 14 ♂), D-16 (17 ♀, 30 ♂), D-17 (15 ♀, 70 ♂), D-18 (33 ♀, 37 ♂), D-20 (18 ♀, 19 ♂), D-21 (2 ♀, 4 ♂), D-22 (27 ♀, 28 ♂), D-24 (2 ♂), D-26 (2 ♀), D-31 (1 ♂), D-32 (3 ♀). *Station* 142: D-3 (5 ♀, 6 ♂). *Station* 143: D-2 (2 ♂). *Station* 146: D-1 (1 ♀, 3 ♂). *Station* 147: D-2 (1 ♀). *Station* 151: D-1 (1 ♀). Cat. Nos. 36,724, 36,857, 36,858, 36,859, 36,860.

Portunus (*Achelous*) *minimus* Rathbun, 1898.

General Range: Gulf of California from Tiburon Island to the Tres Marias Islands. From 4 to 50 fathoms.

Local Distribution: A total of 19 specimens was taken from Arena Bank (Station 136) between 34 and 50 fathoms, on sandy or muddy bottoms, sometimes with weed.

Sex and Size: The 12 females measured between 12 and 17 mm. in length, with ovigerous specimens between 14.5 and 17 mm. The 7 males ranged from 5.3 to 18.5 mm. Detailed measurements of the two largest specimens in the collection are as follows: Ovigerous female, length 17, breadth including spines 26, fronto-orbital width 15, length of cheliped 35. Male, length 18.5, breadth including spines 29, fronto-orbital width 16, length of cheliped 48.5.

Color in Life: Reddish- or purplish-brown blotched with darker brown; chelae banded with purple. Eggs watermelon pink, coral red or orange.

Food: 6 stomachs contained material distributed as follows: with shrimps, 1; with amphipods, 1; with inderminable crustaceans, 1; with indeterminable animal matter, 3.

Breeding: Half of the females were ovigerous. The eggs, .32 mm. in diameter, ranged in number from about 12,500 on a 14.5 mm. crab to about 14,500 on a 17 mm. crab.

Remarks: In the young the outer frontal teeth are less tooth-like and projecting, their inner margins being long with a gentle slope.

This species has not been recorded previously below 40 fathoms.

Material: *Station* 136: D-1 (1 ♀), D-5 (2 ♂), D-6 (2 ♀, 1 ♂), D-12 (1 ♀), D-23 (5 ♀), D-24 (1 ♀), D-30 (2 ♀, 4 ♂). Cat. No. 36,722.

Portunus (*Achelous*) *pichilinquei* Rathbun, 1930.

General Range: From Magdalena Bay to the head of the Gulf of California. From 3 feet to 33 fathoms.

Local Distribution: A total of 62 specimens was taken from the shore of Magdalena Bay, from San Lucas Bay (Station 135) and from the Inez area (Stations 141, 142 and 144), between 3 feet and 33 fathoms on various types of bottoms, usually more or less sandy.

Sex and Size: The 23 males, only three-fifths as numerous as the females, measured between 3.2 and 14 mm. in length. Females ranged from 4.6 to 13.5 mm., with ovigerous specimens from 7.6 to 10 mm.

Color in Life: This species varies considerably in accordance with its

surroundings. The carapace of specimens taken on sandy bottoms was mottled with a fine pattern of brown and grayish-white, and a few small spots of orange. Specimens taken on bottoms with pink or purplish coral and algae, on the other hand, had the carapace coral pink with mottlings of dark reddish-brown or with lighter brown and white. Legs same color as background of carapace, more or less mottled with buff and brown, or barred with pinkish buff, depending on the bottom. Chelae with one or two conspicuous dark bands, one always near the base and sometimes another near the tip. Swimming legs sometimes plain buff (on crabs from sandy bottoms). The males found on both backgrounds have each a bright pink or orange spot on the hepatic region. Underparts pure white. Eggs rose red.

Food: 3 specimens from San Lucas Bay had, respectively, sand, a larval fish and crustacean remains in their stomachs, while 3 specimens from Santa Inez Bay contained the following: with a sponge, a shrimp and the oxystomatous crab, *Randallia americana*, 1; with 2 amphipods and *Randallia americana*, 1; with a single crustacean, 1.

Breeding: Only 6 of the 39 females were ovigerous. The eggs of a medium-sized specimen numbered about 2,100.

Habits: Specimens from bottoms composed of crushed shell and sand sought that material when placed in an aquarium containing samples of various bottoms. The crabs matched the chosen background perfectly in color.

Remarks: Although the lateral spine in all specimens is considerably longer than twice the length of the preceding tooth, so that there is no possibility of confusion with *P. minimus*, in a few specimens the spine is not quite as long as the width of the 3 preceding teeth, as recorded in Rathbun's description of her specimens (1930, p. 78). The outer orbital teeth go through the same developmental phases as in *P. minimus* (see p. 67).

This species has previously been recorded from between 7 and 29 fathoms, so that the present series (from 3 feet to 33 fathoms) increases the known vertical range slightly in both directions.

Material: *Shore of Madalena Bay* (3 feet): (6 ♀). *Station* 135: D-1 and D-9 to D-26, incl. (26 ♀, 16 ♂). *Station* 141: D-4 (1 ♂). *Station* 142: D-1 (6 ♀, 5 ♂), D-2 (1 ♂). *Station* 144: D-2 (1 ♀). Cat. Nos. 36,235, 36,236, 36,723, 36,880, 36,881.

Portunus (*Achelous*) *tuberculatus* (Stimpson), 1860.

General Range: From Cape San Lucas, Lower California, to Panama. From 3 to 29½ fathoms.

Local Distribution: 5 specimens were taken from San Lucas Bay (Station 135) between 3 and 6 fathoms on sandy bottoms.

Sex and Size: The single ovigerous female measured 9.6 mm. in length, 2 young females 9.9 and 10.6 mm., and 2 males 8.3 and 8.9 mm.

Food: The stomachs of 2 specimens contained indeterminable animal matter.

Breeding: The ovigerous female had about 5,400 eggs measuring .27 mm. in diameter.

Material: *Station* 135: D-1 (2 ♀, 2 ♂), D-19 (1 ♀). Cat. No. 36,725.

Callinectes bellicosus (Stimpson), 1859.

General Range: From Point Loma, California, to the Gulf of California.

Local Distribution: 2 young males (Cat. No. 36,879), measuring 12.5 and 14 mm. in length respectively, were taken off Santa Inez Point in floating weed over shallow water.

Family Atelecyclidae.

Pliosoma parvifrons Stimpson, 1860.

General Range: Known only from Cape San Lucas and, questionably, from Carmen Island.

Local Distribution: 5 males, measuring from 4.9 to 17.5 mm. in length, were taken from San Lucas Bay (Station 135) between 6 and 20 fathoms on a sandy bottom.

Color: Plain buff.

Food: Bits of algae; sand.

Material: *Station* 135: D-1 (2 ♂), D-16 (1 ♂), D-26 (2 ♂). Cat. No. 36,726.

Family Xanthidae.

Carpilodes cinctimanus (White), 1847.

General Range: From Arena Bank in the Gulf of California to the Galápagos Islands; South Sea Islands; Japan and Australia to the Gulf of Aden.

Local Distribution: 3 males (Cat. No. 36,761), measuring 5.2, 5.4 and 12.2 mm. in length, respectively, were taken off Arena Bank (Station 136 D-33) at a depth of 2½ fathoms in coral (*Pocillopora ligulata*).

Color in Life: This series shows the development of color with age: The largest specimen was entirely burnt orange with the middle of each lateral margin tipped with white; the characteristic band on the inner side of the palm was pale gray. The 5.4 mm. specimen was bright orange, the mid-lateral margins tipped with white; chelae dark tipped with white, but with no trace of a band on the inner side of the palm. The carapace and underparts of the 5.2 specimen were pure white; the chelipeds were orange except for dark and white dactyls; no trace of a band on inner margin of palm; ambulatories bright orange.

Remarks: A fourth specimen, measuring only 2.7 mm. in length, was taken in the same piece of coral with the above specimens and probably belongs to this species. It differs in having a relatively broader front, the fronto-orbital distance being slightly more, instead of less, than half the greatest breadth. Also, the surface of the carapace is slightly granulate instead of punctate, but this, too, can easily be an age characteristic. In preservative the specimen is entirely white with narrow, vertical, widely separated orange stripes on the carapace; chelae gray tipped with white; no trace of band on inner surface of manus.

Actaea crockeri Glassell, 1936.

(Plate VI, Figure 1).

General Range: Gulf of California. At 34 fathoms.

Local Distribution: A single specimen, the male holotype (Cat. No. 36,731), was taken on Arena Bank (Station 136 D-5) at a depth of 34 fathoms on a bottom composed of rocks and sand with weed.

Remarks: For a description of this species, see *Zoologica*, XXI, No. 17. p. 215. The holotype is deposited in the collections of the Department of Tropical Research of the New York Zoological Society.

Actaea sulcata Stimpson, 1860.

General Range: From Arena Bank in the Gulf of California to the Pearl Islands, Panama. From 2½ to 15 fathoms.

Local Distribution: 2 immature females (Cat. No. 36,762), measuring

8.4 and 8.9 mm. in length were taken off Arena Bank (Station 136 D-33) in coral (*Pocillopora ligulata*) at a depth of 2½ fathoms.

Color in life: Carapace and all legs clear orange-red in larger specimen; orange-red mottled with white in smaller one. Underparts white. Chelae jet black tipped with white.

Food: Indeterminable animal matter.

Glyptoxanthus felipensis Rathbun, 1933.
(Plate VI, Figures 20, 21).

General Range: From San Felipe to Santa Inez Bay in the Gulf of California.

Local Distribution: A single male (Cat. No. 36,885), 8.4 mm. in length, was taken in the Inez area (Station 144 D-2) at a depth of 2½ fathoms on a sandy bottom with weed.

Remarks: This species was known previously only from the 29 mm. male holotype from San Felipe in the Gulf of California (Rathbun, *Proc. Biol. Soc. Washington*, vol. 46, p. 147, 1933). The present young specimen agrees well with the description.

Daira americana Stimpson, 1860.

General Range: From the southern part of the Gulf of California to Ecuador.

Local Distribution: 15 non-ovigerous females (Cat. No. 36,763), measuring from 3.4 to 24 mm. in length were taken from coral (*Pocillopora ligulata*) off Arena Bank (Station 136 D-33) at a depth of 2½ fathoms.

Color in Life: Carapace and chelipeds dark brown, the hairs grayish-brown; ventral side paler except pterygostomian region, which is dark brown also; a longitudinal very pale streak down mid-line of abdomen. Antennules, palps of maxillipeds, inner (anterior) surface of chelipeds, entire surface of ambulatories and outer margins of abdomen brownish tinged with carmine.

Food: 4 stomachs contained seaweed mixed with grains of sand.

Medaeus lobipes Rathbun, 1898.

General Range: From Santa Inez Bay in the Gulf of California to the Bay of Panama; Galápagos Islands. From 5½ to 33 fathoms.

Local Distribution: 1 male (Cat. No. 36,861), measuring 16 mm. in length by 25 in breadth, was taken from the Inez area (Station 143 D-4) at a depth of 25 fathoms on a sandy bottom.

Color in Life: Carapace pale tan mottled with brownish-orange; chelae rich chestnut.

Food: The stomach was crammed with sand.

Remarks: This is the first time this species has been reported north of Cape San Lucas.

Eurypanopeus planissimus (Stimpson), 1860.

General Range: West coast of Mexico, including both east and west coasts of Lower California. Low tide zone and shallow water.

Local Distribution: A total of 6 specimens was taken from the shore of Magdalena Bay and from that of Santa Inez Bay, from the surface (in floating weed) to a depth of 3 feet.

Sex and Size: The series consists of a single ovigerous female measuring 7.9 mm. in length by 12.6 mm. in breadth; 1 young female 5 mm. in

length; and 4 males from 3.2 to 9.2 mm. in length; the largest male measures 14.5 mm. in breadth.

Food: The stomachs of 3 specimens, chosen from both the Magdalena Bay and the Santa Inez Bay material, contained algae.

Breeding: The ovigerous female, taken from Magdalena Bay, carried about 1,450 eggs each measuring .38 mm. in diameter.

Remarks: This species has not previously been taken in the Gulf of California north of La Paz.

Material: *Shore of Magdalena Bay*: (1 ♀, 1 ♂); *in floating weed, Santa Inez Point*: (1 ♀, 2 ♂); *in old augur shell, shore of Santa Inez Bay*: (1 ♂) (uncalcified). Cat. Nos. 36,862, 36,886, 36,887.

Micropanope areolata Rathbun, 1898.

General Range: Southern California and Lower California, including the Gulf, to a depth of 11 fathoms.

Local Distribution: A single male (Cat. No. 36,888), measuring 7.2 mm. in length by 10.3 mm. in breadth, was taken in the Inez Area (Station 144 D-4) between 1½ and 4 fathoms, on a sandy bottom with weed.

Micropanope nitida Rathbun, 1898.

General Range: Gulf of California; 7 to 45 fathoms.

Local Distribution: A single male (Cat. No. 36,730), measuring 6.4 mm. in length, was taken on Arena Bank (Station 136 D-16) at a depth of 45 fathoms, on a sandy-mud bottom with weed.

Remarks: This species has never before been taken below 10 fathoms. Mr. Steve A. Glassell of the San Diego Museum of Natural History has kindly checked the identification of this specimen.

Micropanope polita Rathbun, 1893.

General Range: From Magdalena Bay, Lower California, and the southern part of the Gulf of California to Panama; Galápagos Islands. From 20 to 66 fathoms.

Local Distribution: A total of 39 specimens was taken from Arena Bank (Station 136) and the Inez area (Station 147) between 35 and 50 fathoms on both sandy and muddy bottoms.

Sex and Size: The series contains 12 females, measuring from 2.6 to 6.2 mm. in length (ovigerous females from 3.1 to 3.9 mm.), and 27 males, measuring from 3.2 to 6 mm.

Color in Alcohol: After 4 months in preservative, the specimens were found to be exceedingly variable, even when taken in the same dredge. The range was from dark brown through various shades of red and red mottled with white to pure creamy white. Age and sex apparently were not contributing factors.

Food: 3 stomachs all contained remains of amphipods; 3 others held unidentifiable organic remains.

Breeding: 5 of the 12 females were ovigerous, carrying between 25 and 60 eggs .27 mm. in diameter.

Remarks: The entire series of specimens from Arena Bank (Station 136), numbering all but 2 in the collection, were referred to this species by Mr. Steve A. Glassell who kindly examined them for me. They form an exceedingly variable group. The 26 specimens from Station 136 D-30 are on the whole more typical than the others, and run smaller in size; the bottom in this locality was composed of coarse sand with weed. The others, chiefly from muddy bottoms, have the palms of the chelae almost entirely rough,

while the amount of granulation on the anterior part of the carapace is very variable. The variations in color have already been remarked.

This species has not been reported previously from the Gulf of California.

Material: *Station* 136: D-1 (1 ♂), D-12 (1 ♀), D-13 (1 ♂), D-21 (1 ♀, 1 ♂), D-23 (3 ♀), D-26 (1 ♂), D-27 (2 ♂), D-30 (7 ♀, 19 ♂). *Station* 147: D-2 (2 ♂). Cat. Nos. 36,728, 36,729, and 36,889.

Micropanope xantusii (Stimpson), 1871.

General Range: From the southern part of the Gulf of California to Maria Madre Island, Mexico; Galápagos Islands. In shallow water.

Local Distribution: 14 specimens (Cat. No. 36,764) were taken off Arena Bank (Station 136 D-33) at a depth of 2½ fathoms in coral (*Pocillopora ligulata*).

Sex and Size: The 5 females in the series measured from 3.2 to 7.2 mm. in length, the 9 males from 2.7 to 6 mm.

Food: 2 stomachs each contained both algae and sand.

Breeding: The single ovigerous female, 6.4 mm. long, carried 725 eggs .3 mm. in diameter; the eggs were ready to hatch.

Pilumnus pelagius Glassell, 1936.
(Plate VII, Figures 22, 23).

General Range: Gulf of California at 45 fathoms.

Local Distribution: 3 specimens including the holotype were taken on Arena Bank (Station 136) at 45 fathoms on a muddy bottom.

Remarks: For a description of this species, see *Zoologica*, XXI, No. 17, p. 215. The holotype is deposited in the collections of the Department of Tropical Research of the New York Zoological Society, the paratype in those of the San Diego Society of Natural History.

Pilumnus townsendi Rathbun, 1923.

General Range: The west coast of Mexico from Magdalena Bay and the southern part of the Gulf of California to Manzanillo; Galápagos Islands. From 1½ to 51 fathoms.

Local Distribution: A total of 4 specimens was taken from the Inez area (Stations 141 and 144) between 1½ and 13 fathoms on bottoms composed of sand or crushed shell, always with weed.

Sex and Size: The series consists of 2 non-ovigerous females, measuring 6.2 and 13.2 mm. in length, and 2 males, 8.9 and 12.6 mm. in length.

Food: 2 stomachs contained algae, and sand and algae, respectively.

Remarks: In 3 of the 4 specimens, 1 or both frontal lobes have 4 instead of 3 spines.

Material: *Station* 141: D-1 (1 ♀), D-2 (1 ♀). *Station* 144: D-4 (1 ♂), D-6 (1 ♂). Cat. Nos. 36,890 and 36,891.

Heteractaea lunata (Milne Edwards & Lucas), 1843.

General Range: From San Diego, California, to Valparaiso, Chile. From between tide marks to 10 fathoms.

Local Distribution: 5 males (Cat. No. 36,768), measuring from 2.7 to 7.3 mm. in length, were taken off Arena Bank (Station 136 D-33) at a depth of 2½ fathoms in coral (*Pocillopora ligulata*).

Food: 2 stomachs contained algae.

Domecia hispida Eydoux and Souleyet, 1842.

General Range: Western Atlantic from South Carolina to Brazil; eastern Atlantic, Indian and western and eastern Pacific Oceans; Gulf of California to Panama. Shallow water, among sponges, under stones and in corals.

Local Distribution: 23 specimens (Cat. No. 36,765) were taken off Arena Bank (Station 136 D-33) at a depth of 2½ fathoms in coral (*Pocillopora ligulata*).

Sex and Size: The 10 females in the series measured between 4.1 and 9.3 mm. in length, ovigerous specimens ranging from 6.7 to 9.3 mm.; the 13 males measured between 3 and 8.3 mm.

Food: 4 stomachs contained indeterminable organic matter.

Breeding: 4 of the 10 females were ovigerous, carrying from 585 to 1,050 eggs measuring .3 mm. in diameter.

Trapezia cymodoce ferruginea Latreille, 1825.

General Range: From the southern part of the Gulf of California to Panama; Revilla Gigedos Islands; Galápagos Islands; Indo-Pacific region to the Red Sea.

Local Distribution: 162 specimens (Cat. No. 36,767) were taken off Arena Bank (Station 136 D-33) at a depth of 2½ fathoms in coral (*Pocillopora ligulata*).

Sex and Size: The series contained 87 females measuring from 2.6 to 14.3 mm. in length (ovigerous specimens ranging from 4 to 14.3 mm.) and 75 males, measuring from 3.2 to 16.5 mm.

Color in Life: The specimens varied in general color from orange rufous to grenadine red (by Ridgway's Color Standards), adult males being usually the brightest.

Food: An examination of 12 stomachs showed that 11 contained worms, while 1 held traces of bottom detritus.

Breeding: 61, or almost two-thirds, of the females were ovigerous. They carried from 48 and 61 (on the smallest specimens) to about 2,350 eggs, measuring from .38 to .43 mm. in diameter. Although the size range of ovigerous females (from 4 to 14.3 mm. in length) was so great, the specimens were well distributed throughout this range, no one size predominating noticeably in number.

Remarks: This species has not been reported previously off the eastern Pacific coast north of the Revilla Gigedos Islands.

Trapezia digitalis Latreille, 1825.

General Range: From Arena Bank in the Gulf of California to Panama; from the Red Sea to the Indo-Pacific region.

Local Distribution: 25 specimens (Cat. No. 36,766) were taken off Arena Bank (Station 136 D-33) at a depth of 2½ fathoms in coral (*Pocillopora ligulata*).

Sex and Size: The series contains 12 females measuring from 3.8 to 10.4 mm. in length (ovigerous specimens ranging from 6.2 to 10.4 mm.), and 13 males, measuring from 3.7 to 11.7 mm.

Color in Life: Dorsal surface rich chocolate brown to chestnut brown, except for the palms and dactyls of the ambulatories which are usually bright chestnut red.

Food: An examination of 6 stomachs showed that 5 contained worms while 1 held traces of bottom detritus.

Breeding: 7 of the 12 females in the series were ovigerous. The eggs were found to number from 72 to about 950, and measured from .32 to .38 mm. in diameter.

Remarks: The lateral tooth is well developed in the young. This species has not been recorded previously on the eastern Pacific coast north of Cape San Lucas.

Quadrella nitida Smith, 1869.

General Range: From the southern part of the Gulf of California to Panama. From 6 to 75 fathoms.

Local Distribution. A total of 26 specimens was taken from Arena Bank (Station 136) and Gorda Banks (Station 150) between 35 and 75 fathoms on bottoms ranging from sandy to muddy, but always in association with gorgonids.

Sex and Size: The series contains 12 females measuring from 6.8 to 10.2 mm. in length and 14 males measuring from 5.1 to 8.9 mm.

Color in Life; Habits: Carapace, ambulatories and underparts pure white; chelipeds white or variously colored with shades of red, yellow or orange; usually a gray, brown or black bar across base of chelae.

The color of these crabs shows an amazing correlation with their mode of life. Every specimen was taken in association with gorgonids, most frequently a species (*Muricea miser* Verrill) which was either entirely white or with the tips of the branches brightly colored, the shade varying in different specimens from bright golden yellow through peach-colored to bittersweet orange and flame scarlet. The crabs, still alive, were often found clinging to the branches with their chelae so tightly that they could not be dislodged except by breaking off the chelipeds.

The remarkable part of the association was this: In almost every case, the crabs which were found on all-white gorgonids were entirely white themselves (except, sometimes, for a dark, typically xanthid bar across the chelae), while those clinging to specimens with the branch tips colored were white except for the chelipeds (or, sometimes, the manus and dactyls only) which always matched the shade of the gorgonid fronds more or less perfectly. Moreover, the crabs almost always clung to the branches in such a position that the white carapace and ambulatories were surrounded by the white basal parts of the branches, while the colored chelipeds were among the colored outer tips. In several examples an all-white crab was found in a gorgonid with colored tipped branches, but each of these clung to the white central portion of the coral.

On 4 occasions, single pairs were found close together in the same gorgonid treelet, 3 of the females being ovigerous. In 2 of these pairs, both male and female were completely white on an all-white gorgonid; in the other 2 pairs, either the male or the female had colored chelipeds paler than those of its mate, the outer fronds of the gorgonid being colored in both cases.

Only a single specimen, the carapace white as always, was taken on a completely colored gorgonid.

Although these crabs were all caught at depths (210 to 450 feet) at which all of the red rays and most of the yellow rays of the spectrum are entirely absent, so that these shades would appear grayish or black to our eyes, nevertheless, they would stand out to a certain extent against the lighter gray of pure white objects, so that the color patterns of *Quadrella* are evidently an example of protective coloration.

Food: An examination of 10 stomachs showed that 5 contained worms, and 4 brittle stars, while 1 was empty. Both worms and brittle stars were often found in the branches of the same gorgonids with the crabs.

Breeding: 6 of the dozen females taken were ovigerous; they carried from 420 to 1,000 eggs measuring between .32 and .38 mm. in diameter.

Remarks: Some specimens have 9 or 10 spines instead of only 6 to 8 on the merus of the chelipeds.

This species has not been reported previously below 31 fathoms.

Material: *Station* 136: D-1 (1 ♂), D-12 (1 ♀), D-23 (1 ♀, 2 ♂), D-24 (3 ♀, 1 ♂), D-26 (2 ♀, 4 ♂). *Station* 150: D-9 (1 ♀), D-10 (3 ♀, 5 ♂), D-16 (1 ♀, 1 ♂). Cat. Nos. 36,394, 36,732 and 36,733.

Family Goneplacidae.

Chasmocarcinus ferrugineus Glassell, 1936.

(Plate VII, Figure 24).

General Range: Gulf of California. At 45 fathoms.

Local Distribution: 3 specimens were taken on Arena Bank (Station 136 D-21) at a depth of 45 fathoms on a muddy bottom.

Color in Life: Reddish-brown; carpus, manus and dactyls of chelipeds white.

Remarks: A description of this species will be found in *Zoologica*, XXI, No. 17, p. 216. The holotype (Cat. No. 36,735) is deposited in the collections of the Department of Tropical Research of the New York Zoological Society, the paratype in those of the San Diego Society of Natural History.

Chasmocarcinus latipes Rathbun, 1898.

General Range: Cedros Island and Magdalena Bay, both off the west coast of Lower California. From 38 to 51 fathoms.

Local Distribution: 9 specimens were taken off Cedros Island (Station 126) between 38 and 40 fathoms on muddy bottoms.

Sex and Size: The collection contains 5 non-ovigerous females, measuring between 11 and 12 mm. in length, and 4 males, between 9 and 14.5 mm. in length.

Color in Life: Carapace and chelipeds grayish-white, center of carapace pink; basal segments of all specimens usually brown. Pubescence brown.

Remarks: This species has been known previously from a single female taken in Magdalena Bay. There is no sexual variation, and the specimens agree well with the original description.

Material: *Station* 126: D-1 (1 ♂), D-2 (5 ♀, 1 ♂), D-4 (2 ♂). Cat. No. 36,893.

Family Cymopoliidae.

Cymopolia cortezi, sp. nov.

(Plate VIII, Figure 25).

Type: Male, holotype; Cat. No. 36,895, Department of Tropical Research of the New York Zoological Society; Station 147, Dredge 2, from Santa Inez Bay in the Gulf of California, 26° 57′ 30″ N. Lat., 111° 48′ 30″ W. Long.; 60 fathoms; bottom composed of mud and crushed shell; April 17, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Front with 2 large, non-emarginate, triangular teeth; 2 sharp antero-lateral teeth; last leg reaching beyond merus of third ambulatory; distal lobe of merus of ambulatories acute.

Description: Carapace not much broader than long, moderately convex with 2 large, acute, antero-lateral teeth besides orbital tooth; both of these teeth point obliquely outward, their bases nearly touching; first tooth slightly broader than second. Tubercles of carapace conspicuous, trending forward, becoming increasingly laminate transversely toward posterior part of carapace; intervening spaces almost smooth except for a few small granules and hairs, the latter being more numerous posteriorly. Ridge above

posterior margin crenulate with 4 large tubercules and 4 intervening small ones.

Entire front divided by a deep median notch, slightly wider than deep, into 2 large, triangular teeth, their apices forming almost perfect right angles. First sinus of supraorbital margin narrowly U-shaped, the second broadly V-shaped; middle tooth subacute, equilaterally triangular; outer tooth acute, lower and narrower than middle tooth, and separated from outer tooth of orbit by a broad, triangular notch. Outer tooth of orbit directed obliquely forward, the inner margin entirely straight, the outer straight except for the slightly convex distal portion. Both suborbital sinuses V-shaped, the outer narrowly, the inner broadly. Outer suborbital lobe very convex, almost triangular, its inner margin nearly twice as long as its outer one. Inner suborbital lobe rudimentary, very low, with an oblique, slightly convex margin half concealed by the pterygostomian lobe. The latter is strongly developed, with a sinuous margin ending in a small, blunt, tooth-like projection, far in advance of the outer suborbital lobe.

Chelipeds slender, the right one slightly the longer with its manus moderately tumid. Tips of fingers crossing.

First ambulatory leg reaching middle of merus of second leg; second leg about 1⅔ times the maximum width of carapace. Merus of ambulatories each with a low dorsal crest ending in an acute lobe; carpus with a low dorsal crest with 2 subacute lobes, basal and distal; propodus slightly enlarged distally, its low dorsal crest extending both basally and distally in a small, horizontal tooth. Last leg reaching slightly beyond end of merus of third leg.

Measurements: Male holotype: Length of carapace, 7.9 mm.; breadth of carapace including second antero-lateral teeth, 10.1 mm.; breadth of carapace excluding second antero-lateral teeth, 9.4 mm.; length of first ambulatory, 12 mm.; length of second ambulatory, 16.8 mm.

Material Examined: The male holotype.

Remarks: This proposed species is allied to *Cymopolia obesa* A. Milne Edwards and to *Cymopolia tuberculata* Faxon. It differs from both in the character of the front and of the antero-lateral teeth, but has more characters in common (namely, the length of the last leg and the number of antero-lateral teeth) with *C. obesa* from the Gulf of Mexico than it has with *C. tuberculata* from the Bay of Panama.

Cymopolia lucasii (Rathbun), 1898.

General Range: Cape San Lucas and southern part of the Gulf of California. From 31 to 60 fathoms.

Local Distribution: 2 specimens were taken from Arena Bank (Station 136) and Gorda Banks (Station 150), respectively, between 50 and 60 fathoms on muddy and sandy bottoms.

Sex and Size: The non-ovigerous female from Arena Bank measured 13.6 mm. in length, the male from Gorda Banks 11.5 mm.

Remarks: This species has been known previously only from a series of 7 specimens taken by the *Albatross* off Cape San Lucas at a depth of 31 fathoms.

Material: *Station* 136: D-27 (1 ♀). *Station* 150: D-9 (1 ♂). Cat. Nos. 36,738 and 36,739.

Cymopolia zacae Glassell, 1936.
(Plate VIII, Figure 26).

General Range: Gulf of California. At 45 fathoms.

Local Distribution: A single specimen, the male holotype, was taken on Arena Bank (Station 136) at a depth of 45 fathoms on a muddy bottom.

Remarks: For a description of this species, see *Zoologica*, XXI, No. 17, p. 217. The holotype is deposited in the collections of the Department of Tropical Research of the New York Zoological Society.

Cymopolia zonata Rathbun, 1893.

General Range: Magdalena Bay, Lower California, and the Gulf of California. From ½ to 40 fathoms.

Local Distribution: A total of 49 specimens was taken from the shore of Magdalena Bay, from Arena Bank (Station 136) and from the Inez area (Station 142) between ½ and 40 fathoms, on sandy and muddy bottoms, usually with weed.

Sex and Size: The series contains 19 females measuring between 4.7 and 11.5 mm. in length, and 30 males, between 5.4 and 12.4 mm. The 2 ovigerous females each measured 11.5 mm.

Color in Life: Carapace and chelipeds varying from rose through pomegranate purple to dark maroon. A pair of elongate longitudinal white spots in middle of carapace, one on each side of mid-line. Underside bluish-white. Eyes greenish-buff. Ambulatories banded with rose and buff, or with pink and white.

Food: The 10 stomachs examined all contained both sand and algae.

Breeding: An ovigerous female carried about 1,050 eggs measuring .32 mm. in diameter.

Remarks: This species has not been reported previously in less than 8 fathoms of water.

Material: *Shore of Magdalena Bay*: (1 ♂). *Station* 136: D-6 (1 ♂), D-23 (1 ♂), D-30 (3 ♀, 4 ♂). *Station* 142: D-1 (7 ♀, 12 ♂), D-2 (9 ♀, 11 ♂). Cat. Nos. 36,736, 36,899 and 36,900.

Family Grapsidae

Grapsus grapsus (Linnaeus), 1758.

General Range: Pacific coast from Lower California (from San Benito Island) to Chile; Galápagos Islands; western Atlantic from southern Florida and the Bahamas to Pernambuco, Brazil; eastern Atlantic.

Local Distribution: Abundant on the rocks around Cape San Lucas and the shores of Santa Inez Bay. One young male (Cat. No. 36,902) from Santa Inez point, preserved.

Pachygrapsus crassipes Randall, 1840.

General Range: From Oregon to the Gulf of California; Galápagos Islands; Chile; Japan and Korea.

Local Distribution: 2 specimens were taken, a non-ovigerous female, 14.5 mm. in length, from the shore of Magdalena Bay (Cat. No. 36,903), and an ovigerous female, 25 mm. in length, from the shore of Santa Inez Bay (Cat. No. 36,904).

Food: The stomach of the Magdalena Bay specimen contained algae; that from Santa Inez Bay was empty.

Breeding: The latter female carried about 5,000 hatching eggs, measuring .43 mm. in diameter. There were well developed internal eggs in addition.

Planes minutus (Linnaeus), 1758.

General Range: Pelagic in tropical and temperate seas, and occasionally on shore, in weed, on turtles, and logs, and in jellyfishes and sponges.

Local Distribution: An ovigerous female (Cat. No. 36,927), measuring 24.5 mm. in length, was taken in Santa Inez Bay attached to the tail of a green turtle.

Food: Finely digested animal matter. It would be interesting to know if this material represents the excrement of the turtle.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Podochela vestita*, male, length 21.5 mm., dorsal view.
Fig. 2. Same, ventral view.
Fig. 3. *Podochela vestita*, female, length 20 mm., dorsal view.
Fig. 4. Same, ventral view.

PLATE II.

Fig. 5. *Eucinetops lucasii*, male, length 6.9 mm., dorsal view.
Fig. 6. Same, ventral view.
Fig. 7. *Epialtus minimus*. Series taken at a single locality in Santa Inez Bay (Station 144), showing variation. From left to right, in the top row the first, third, and fourth specimens are males; in the second row the first and third specimens are males; in the third row the third specimen is a male; in the fourth row all specimens are females. (x 1.2).

PLATE III.

Fig. 8. *Rochinia vesicularis*, male, length ca. 19.5 mm., dorsal view. Tips of rostral horns broken.
Fig. 9. Same, ventral view.
Fig. 10. *Mithrax mexicanus*, male holotype, length 16.2 mm., dorsal view.
Fig. 11. Same, ventral view.
Fig. 12. *Macrocoeloma villosum*, male, length 9.6 mm., dorsal view.

PLATE IV.

Fig. 13. *Stenocionops beebei*, female holotype, length 56 mm., dorsal view.
Fig. 14. Same, ventral view.
Fig. 15. Same, lateral view.

PLATE V.

Fig. 16. *Parthenope (Pseudolambrus) excavata*, male, length 15 mm., dorsal view.
Fig. 17. Same, ventral view.
Fig. 18. *Parthenope (Pseudolambrus) triangula*, male, length 8.4 mm., dorsal view.

PLATE VI.

Fig. 19. *Actaea crockeri*, male holotype, length 5.5 mm., dorsal view.
Fig. 20. *Glyptoxanthus felipensis*, male, length 8.4 mm., dorsal view.
Fig. 21. Same, ventral view.

PLATE VII.

Fig. 22. *Pilumnus pelagius*, female holotype, length 9 mm., dorsal view.
Fig. 23. Same, ventral view.
Fig. 24. *Chasmocarcinus ferrugineus*, female holotype, length 9.2 mm., dorsal view.

PLATE VIII.

Fig. 25. *Cymopolia cortezi* sp. nov., male holotype, length 7.9 mm., dorsal view.
Fig. 26. *Cymopolia zacae*, male holotype, length 8.5 mm., dorsal view.

FIG. 2.

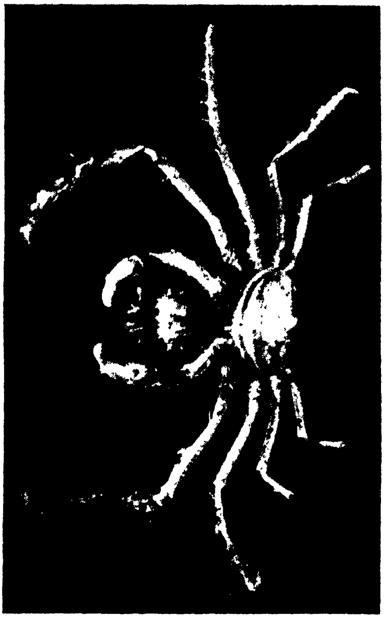


FIG. 4.

FIG. 1.

FIG. 3.

BRACHYGNATHOUS CRABS FROM THE GULF OF CALIFORNIA
AND THE WEST COAST OF LOWER CALIFORNIA.

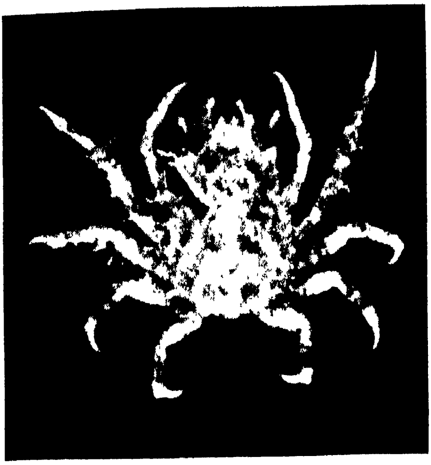


FIG. 5.

FIG. 6.

FIG 7.

BRACHYGNATHOUS CRABS FROM THE GULF OF CALIFORNIA
AND THE WEST COAST OF LOWER CALIFORNIA.

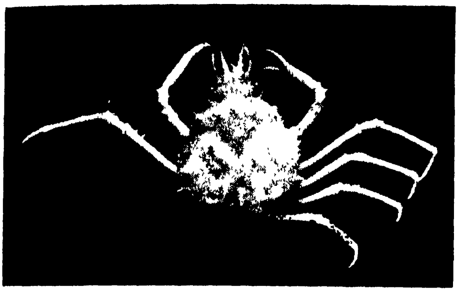


FIG. 8.

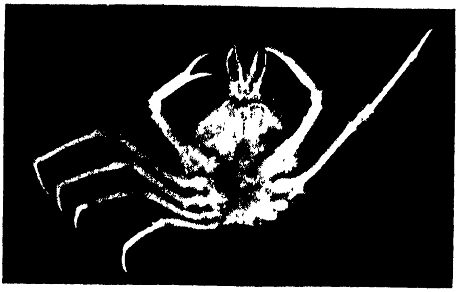


FIG. 9.

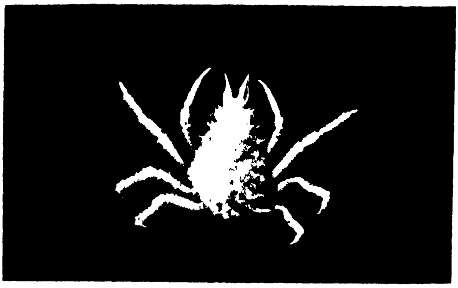


FIG. 10.

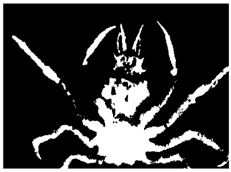


FIG. 11.

FIG. 12.

BRACHYGNATHOUS CRABS FROM THE GULF OF CALIFORNIA AND THE WEST COAST OF LOWER CALIFORNIA.

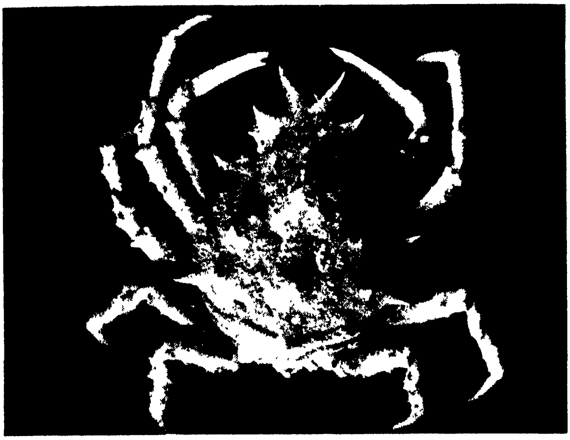


FIG. 13.

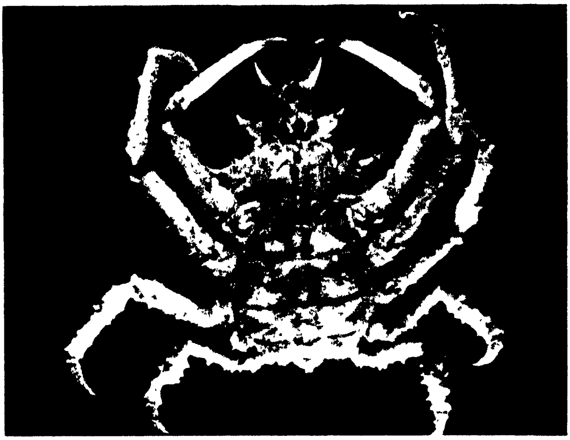


FIG. 14.

FIG. 15.

BRACHYGNATHOUS CRABS FROM THE GULF OF CALIFORNIA AND THE WEST COAST OF LOWER CALIFORNIA.

FIG. 16.

FIG. 17.

FIG. 18.

BRACHYGNATHOUS CRABS FROM THE GULF OF CALIFORNIA
AND THE WEST COAST OF LOWER CALIFORNIA.

FIG. 19.

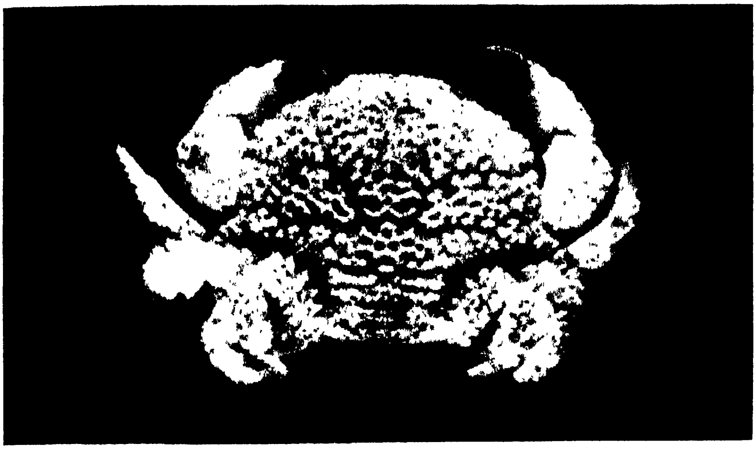


FIG. 20.

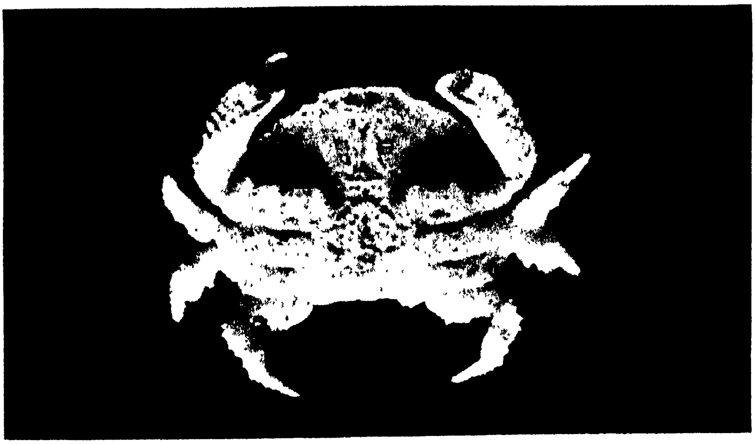


FIG. 21.

BRACHYGNATHOUS CRABS FROM THE GULF OF CALIFORNIA AND THE WEST COAST OF LOWER CALIFORNIA.

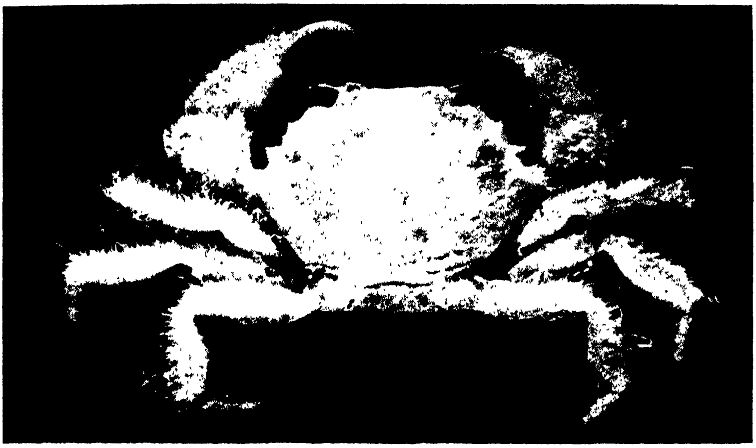


FIG. 22.

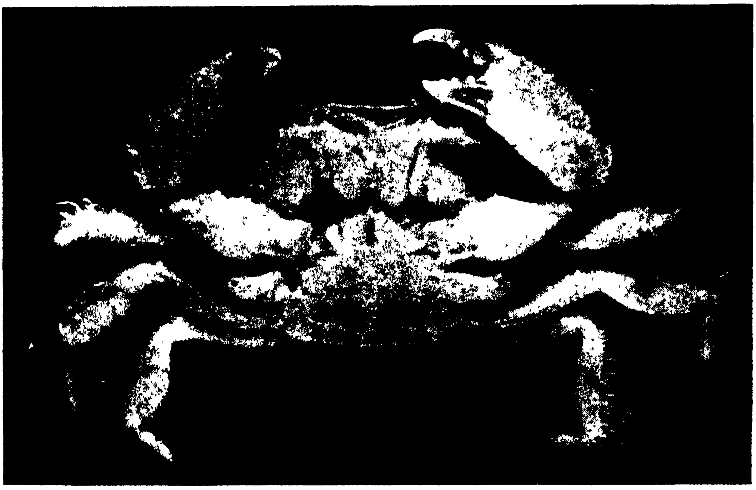


FIG. 23.

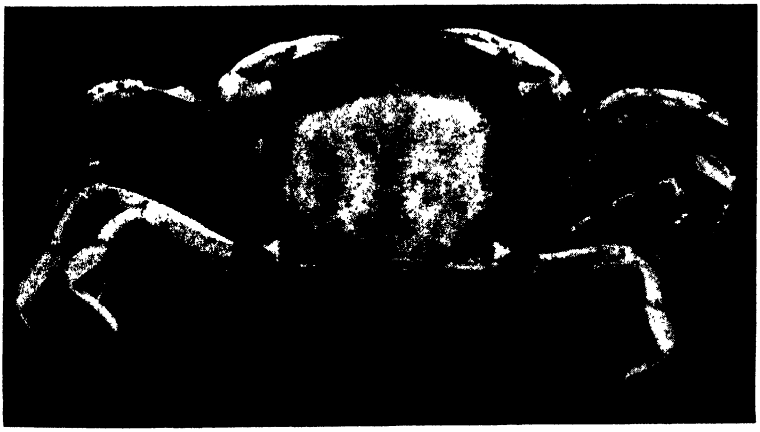


FIG. 24.

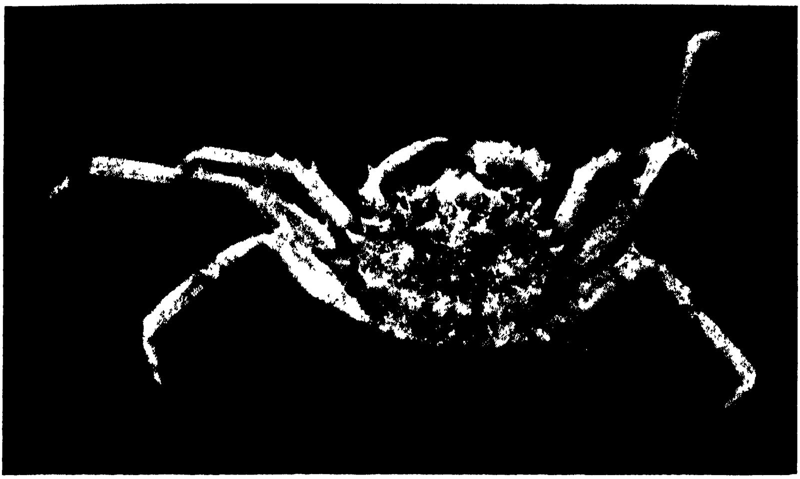


FIG. 25.

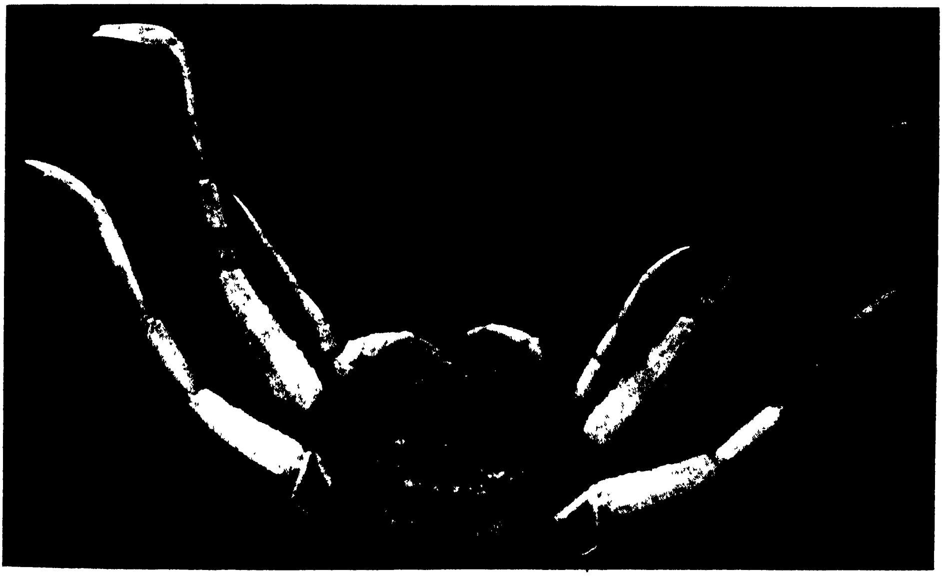


FIG. 26.

BRACHYGNATHOUS CRABS FROM THE GULF OF CALIFORNIA
AND THE WEST COAST OF LOWER CALIFORNIA.

4.

The Templeton Crocker Expedition. IV. Porcellanid Crabs from the Gulf of California.[1]

STEVE A. GLASSELL

Research Associate in Crustacea,
San Diego Society of Natural History.

(Plate I).

[Note: This is the fourth of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica*, No. 2, pp. 33 to 46.]

CONTENTS.

INTRODUCTION.

This interesting collection of porcellanids from the Gulf of California comprises 11 species in 4 genera. New locality records are noted, extending the known ranges of several species both geographically and bathymetrically.

[1] Contribution No. 522, Department of Tropical Research, New York Zoological Society

Two new species are described, both being collected at the same time and place, in shallow water. Also, new types are proposed for *Pachycheles biocellatus* (Lockington), as the original types for this species are not extant.

Family PORCELLANIDAE.

Genus *Petrolisthes* Stimpson.

Petrolisthes hirtispinosus Lockington.

Petrolisthes hirtispinosus Lockington, *Ann. Mag. Nat. Hist.*, ser. 5, vol. 2, 1878, p. 400 (type-locality, Mulege Bay, Gulf of California, Mexico; type not extant), (not *Petrolisthes edwardsii* Saussure).

"*Petrolisthes hirtispinosus* ? Lockington," Schmitt, *Proc. Cal. Acad. Sci.*, ser. 4, vol. 13, no. 24, 1924, p. 384.

General Range: So far only recorded from the Gulf of California. A littoral form.

Local Distribution: A total of 14 specimens (Cat. No. 36,808) was taken off Arena Bank (Station 136 D-33) in coral (*Pocillopora ligulata*) at a depth of 2½ fathoms.

Sex and Size: This entire series of 8 males and 6 females is composed of adolescents and juveniles. The largest specimen, a male, has the following dimensions: length of carapace 6 mm., width 5.7 mm. As neither Lockington nor Schmitt has given the dimensions of their specimens, I will give the measurements for normal adults, collected by myself, at the following localities: Adult female from Conception Bay (near type-locality), Baja California, Mexico, January 20, 1932: length of carapace 10 mm., width 11 mm. Adult male from San Pedro Bay, Sonora, Mexico, December 25, 1931: length of carapace 10 mm., width 9.7 mm.

Color: This species is not nearly as highly colored in life as it is in alcohol, the preservative intensifying the coloration for a considerable time. In life it is a light red mottled with cream, spines and lobes, yellow to white margined with a deep red; the undersides of the hands are very conspicuous, a bright pink.

Habitat: It is usually found in the inter-tidal zone, beneath rocks.

Remarks: The collection of this series is the first indication that the species may be obtained at a depth, as it has heretofore been taken only in the tidal zone.

Petrolisthes crenulatus Lockington.

Petrolisthes crenulatus Lockington, *Ann. Mag. Nat. Hist.*, ser. 5, vol. 2, 1878, p. 398 (type-locality, Port Escondido, Baja California, Mexico).

General Range: Gulf of California.

Local Distribution: 2 specimens (Cat. No. 36,810) were taken off Arena Bank (Station 136 D-33) in coral (*Pocillopora ligulata*) at a depth of 2½ fathoms.

Sex and Size: The specimens are male and female adolescents. The male, which is the larger, has length of carapace 6 mm., width 6 mm. Adult specimens of this species are much larger than the above. A male, collected by the author at the type-locality, has the following measurements: length 13.5 mm., width 15 mm.

Color in Life: This is a large and very distinctive species; its color of cream and orange-red makes it conspicuous.

Habitat: It is usually found in the lower part of the inter-tidal zone under stones.

Remarks: Lockington described this species from a single immature specimen (sex not given). The number of teeth on the anterior margin of the carpus is subject to variation; three or four may be present. This is the first record of this species having been taken outside of the inter-tidal zone.

Petrolisthes polymitus Glassell, sp. nov.

(Plate I; Figure 1).

Type: Male, holotype; Cat. No. 36,918, Department of Tropical Research of the New York Zoological Society; Station 136, Dredge 33; from the Gulf of California off Arena Bank, 25° 26′ N. Lat., 109° 24′ 30″ W. Long.; 2½ fathoms; May 2, 1936; in coral (*Pocillopora ligulata*); collected by William Beebe on the Templeton Crocker Expedition. Deposited in the collection of the New York Zoological Society.

Diagnosis: Carapace with wide, flattened, transverse plications, those posterior to the cardiac region extending across the carapace and joined in pairs at the median line; a single forward-pointing spine on the shoulder. Front serrate, not trifid. Chelipeds unequal; carpus four- or five-spined; dactyli with a single, distal spine, at termination of upper crest, extending forward over curved tip of dactylus; outer margin of hand spinose.

Description: Carapace slightly longer than wide, depressed, the surface crossed with wide, flattened, transverse plications, anteriorly interrupted by the gastro-cardiac regions and the cervical groove; those plications posterior to the cardiac region, four in number, are entire, though joined in pairs at the median line. A verticil on each side of the cardiac region, and a pit on each side of the proximal end of the mesogastric region; a longitudinal, narrow, median sulcus extends back some distance on the gastric region; this sulcus divides a transverse ridge extending between the bases of the upper ocular spines, and the protogastric ridge lying behind it. The front is broadly triangular, apex slightly depressed, margin minutely serrate; the upper surface on each side of the median sulcus to the distal ocular hiatus is obliquely plicate. The upper ocular margin is armed with a single, long, sharp, forward-pointing spine. The lateral margin of the carapace is armed with a single, sharp-pointed spine on the shoulder behind the cervical groove. The eyes are large and stout. The basal joint of the antennae is armed subdistally with a prominent spine; the second peduncle is stout, short and unarmed; the third peduncle is almost globular, with less diameter than that of the second.

Chelipeds subsimilar, unequal; merus with an inner distal upward-pointing spine and two small carpal-articulation spines; carpus, including spines, more than half as wide as long, armed with four or five sharp-pointed, serrated spines on inner margin; upper surface obliquely plicated with squamous tubercles; the outer margin is armed distally with a row of three or four sharp spines; the hands are unequal, subsimilar, stout, armed on their outer margin from near the proximal end to the base of the pollex with a row of well-separated, forward-pointing, small, sharp spines; from the distal spine of this series to the upturned tip of the pollex, the margin is serrated with a fine beading; the inner margins of the hands are lightly beaded; the surface of the outer half of the hands is covered with granulations and small squamous tubercles. The median ridge of the major hand is composed of granular-edged plications which form an obtuse angle at the median line, thence run obliquely and entire to a point near the inner border of the hand; these plications differ in the minor hand, in that they are not entire, but broken up into separate rugae; the interspaces between plications and granules are filled with a microscopic pile, only to be seen under a lens. The dactyli of both hands are armed at the distal end of their upper crest with a single, sharp, outward-pointing spine, as in some species of the

Galatheidae. The fingers of the major hand gape from base to crossing tips, those of the minor hand fit closely together; on the under side of both hands within the gape of the fingers is a close pile of tomentum; the under surface of the hands is lightly granular on the inner half, punctate on the outer.

The ambulatory legs are stout, with a few scattered setae; merus with a small, subdistal spine on upper crest; the dactyli are long, sharp, compressed, and curved only at the corneous tip, their length is slightly more than half the propodal length, they are armed on their lower margin with a row of short spines.

The telson of the abdomen is composed of seven plates. The ischium and merus of the outer maxillipeds are transversely plicated with red striations.

Color in Alcohol: This beautiful little crab has the appearance of being embroidered in colored silks, somewhat similar in effect to the Peking stitch; the plications are an orange-red, laterally merging into a yellow on the median line; the subcardiac whorls, protogastric and frontal ridges are a deep red. The under side of the chelipeds is a brilliant carmine, mottled with white. The propodi of the ambulatories are distally banded with mottled carmine. The median line of the abdomen is paralleled with red chromataphores, blending into orange. The hands give the impression of being banded with orange and white.

Measurements: Male holotype, length of carapace 5 mm., width 4.8 mm.; carpus length 4 mm., width including spines 2.5 mm.; length on hands 7 mm., width of major hand 2.9 mm., of minor hand 2.4 mm.

Material Examined: The holotype. This specimen had the third left leg and the first right leg regenerating.

Habitat: Collected in 2½ fathoms in coral (*Pocillopora ligulata*). Associated with *P. hirtispinosus* Lockington.

Remarks: This proposed species is allied to *P. hirtispinosus* Lockington, 1878, but differs from that species by having the carapace plicated, instead of not plicated, by being nearly free from tomentum, instead of being covered with a fine pile of pubescence. It is allied to *P. felipensis* Glassell, 1936, but differs from that species by having the plications continue entire across the carapace posterior to the cardiac region instead of not being continued and by there being a single spine at the termination of the cervical groove, instead of a row of spines continued onto the carapace at this point. Both *P. felipensis* and *P. polymitus* have the peculiar sub-bifid-tipped dactyli of the chelipeds, a unique characteristic.

Genus *Pisosoma* Stimpson.

Pisosoma flagraciliata Glassell, sp. nov.

(Plate I; Figure 2)

Type: Female, holotype; Cat. No. 36,919, Department of Tropical Research of the New York Zoological Society; Station 136, Dredge 33; from the Gulf of California off Arena Bank, 25° 26′ N. Lat., 109° 24′ 30″ W. Long.; 2½ fathoms; May 2, 1936; in coral (*Pocillopora ligulata*); collected by William Beebe on the Templeton Crocker Expedition. Type deposited in the collections of the New York Zoological Society.

Diagnosis: Carapace sculptured anteriorly, about as long as wide. Antennae with flagellum ciliate. Chelipeds short, stout, naked. Ambulatory legs stout, with sparse setae.

Description: Carapace about as long as wide, with regions well-defined anteriorly, with branchial, hepatic and protogastric prominences separated by grooves; the posterior half much smoother, polished, lightly punctate and with light lateral plications. The front in a dorsal view is strongly

arched, sinuous in a front view, with a triangular median tip. Eyes large, stalks stout. Antennal peduncles stout; the first peduncle with two minute spines on its outer, distal face; the second peduncle with a single spine at its outer distal end; the flagellum is ciliated at its joints, those on the anterior side being longest.

Chelipeds short, stout, naked; merus short on dorsal side with a very narrow margin, armed with a small, subvertical lobe on the distal, inner end; the ventral margin extending to this lobe is serrated at the carpal articulation, and flattened for the reception of the hand when flexed; the carpus is nearly as wide as long, flattened on the upper surface, and armed on its inner, arcuate margin with three or four large, subtriangular teeth, the proximal the largest; a tumid ridge extends from the proximal end to a point near the distal end, its anterior, imperceptible border being on the median line; its posterior border is a deep sulcus paralleling the rounded, obliquely plicated, outer margin; the surface of the carpus is transversely plicated from the anterior base of the obliquely plicated ridge to the inner margin; the flexed hand fits into a concavity underneath the thin, toothed, inner edge of the carpus; the hands are thick, stout, subequal but dissimilar; a distinct sulcus parallels the outer margin to a point near the tip of the pollex; the upper surface is granulous, the under slightly punctate; the fingers of the major chela are gaping, their tips blunt and crossing; those of the minor hand are straighter, lightly toothed, and joining from gape to crossed tips.

Ambulatory legs stout and lightly setose; their dactyli are strong, curved, corneous, and are half the length of their propodi. The abdominal telson is composed of five plates.

Sexual Variation: The carapace of the males is slightly longer than wide.

Color in Alcohol: Carapace with a ground color of red; plications red and white. Chelipeds with maroon blotches, the plications banded with red and white; the fingers red with white tips. Ambulatory legs banded with red and white.

Measurements: Female holotype (the largest of the series), length of carapace 4.9 mm., width 5.1 mm.; length of carpus 3.4 mm., width 3 mm. Male paratype, length 4.2 mm., width 4 mm.

Material Examined: A series of 18 specimens (Cat. Nos. 36,919 and 36,920), equally divided as to sex, mostly juveniles, the females nearly all ovigerous. The types were selected from this series.

Habitat: Collected in coral (*Pocillopora ligulata*) at a depth of 2½ fathoms. Associated with *P. sinuimanus* Lockington, *Pachycheles biocellatus* (Lockington), and *Pachycheles sonorensis* Glassell.

Remarks: This proposed species is allied to *P. serrata* Benedict, 1900, but differs in the carapace, the anterior regions being prominent, instead of nearly smooth, by the chelipeds being more nearly equal, instead of very unequal, and by the presence of a deep paralleling sulcus following the outer, obliquely plicated border.

This species, like *P. lewisi* Glassell, 1936, has the flagellum of the antennae ciliated, but unlike the latter, the cilia are more pronounced.

In general appearance, the chelipeds in this species greatly resemble those of the genus *Pachycheles*. In this species, however, the epimera are posteriorly entire.

Pisosoma sinuimanus Lockington.

Petrolisthes (*Pisosoma*) *sinuimanus* Lockington, *Ann. Mag. Nat. Hist.*, ser. 5, vol. 2, 1878, p. 401 (type-locality [?], La Paz and Port Escondido, Lower California, Mexico; types not extant).

Petrolisthes sinuimanus (Lock.), Nobili, *Boll. Mus. Zool. Anat.* comp. R. Univ. Torino, vol. 16, no. 415, 1901, p. 15 (Isle of Flamenco, Ecuador). —Rathbun, *Proc. U. S. Nat. Mus.*, vol. 38, 1910, p. 599.

General Range: Gulf of California; Ecuador (Nobili).

Local Distribution: 8 specimens (Cat. No. 36,812) were taken off Arena Bank (Station 136 D-33) in coral (*Pocillopora ligulata*); at a depth of 2½ fathoms.

Sex and Size: The series includes 2 males and 6 females. The largest specimen, a male, has the following measurements: length of carapace 4.5 mm., width 4.3 mm.

Color in Life: In color this species varies from a light cream to buff; the ventral side is slightly iridescent.

Habitat: It is found throughout the Gulf of California, in the intertidal zone, on the under side of rocks.

Remarks: This is the first recorded collecting of this species below the tidal zone.

Genus *Pachycheles* Stimpson.

Pachycheles biocellatus (Lockington).

Petrolisthes (*Pisosoma*) *biocellatus* Lockington, *Ann. Mag. Nat. Hist.*, ser. 5, vol. 11, 1878, p. 403 (exact type-locality unknown. Lower California).

Pisosoma aphrodita Boone, *Zoologica*: N. Y. Zoological Soc., vol. 14, no. 1, 1932, p. 53, fig. 17, a-b (type-locality, off Hood Island, Galápagos).

This species, as recorded by Lockington, was collected somewhere on the peninsula of Lower California, and described by him from two specimens, sex not being given. These specimens, the types, were destroyed in the San Francisco fire of 1906.

From a careful analysis of Lockington's description, I am convinced that a typographical error exists in the one measurement he records: "The larger of the two specimens measures barely three centimetres in length." He then states in another paragraph: "This pretty little species is a typical *Pisosoma.*" If we interpret Lockington's word "centimetres" to mean millimetres, then the sense of his statement "This pretty little species," etc., becomes apparent, for by no stretch of the imagination would a porcellanid with a length of three centimetres be considered diminutive. When we assume that Lockington was in reality working on juvenile specimens, it is not to be wondered at that he selected the genus *Pisosoma,* instead of *Pachycheles,* as it would have been difficult for him to have determined, assuming also that he had dried specimens, that the epimera of the carapace is posteriorly broken up, with the posterior subquadrate part separated by a cutaneous inter-space from the remainder.

From a series of 17 specimens collected off Arena Bank, Gulf of California, Mexico, I propose to designate one female the neotype and one male the allotype.

Neotype: Female; Cat. No. 36,821, Department of Tropical Research of the New York Zoological Society; Station 136, Dredge 33; off Arena Bank, 25° 26′ N. Lat., 109° 24′ 30″ W. Long.; 2½ fathoms; May 2, 1936; in coral (*Pocillopora ligulata*); collected by William Beebe on the Templeton Crocker Expedition. Neotype deposited in the collections of the New York Zoological Society.

Allotype: Male; Cat. No. 36,822, Department of Tropical Research of the New York Zoological Society; collected at the same place and time as the neotype. Allotype deposited in the collections of the New York Zoological Society.

Diagnosis: Carapace depressed, broader than long, punctate, polished, naked, carmine, with white spots on the shoulders and white lunet beside the cardiac region. Chelipeds short, heavy, naked, subequal; inner margin of carpus arcuate, unarmed. Telson of abdomen with five plates.

Description: Carapace broadly wide at the shoulders, wider than long, transversely depressed, convex fore and aft; regions lightly outlined, a reversed lunet on each side of the cardiac region; the protogastric ridges have their apices on the median line, from whence they curve backward and outward; the lateral margin is lightly plicate, more prominent posteriorly; the front is slightly arched, with a small depressed lobe forming the inner terminus of the upper ocular margin; the postorbital spine is acute. The first antennal peduncle is armed on its anterior margin with a triangular lobe; the others unarmed; flagellum naked.

Chelipeds very stout, short, subequal, lightly punctate, naked; merus with upper surface lightly, transversely plicate, a laminate, subhorizontal, triangular, inner, distal lobe, its distal end passing the carpal hinge; the carpus is nearly as wide as long, the upper anterior portion produced forward as a thick lamina; this margin is strongly arched, unarmed, sinuous, and indistinctly divided into three lobes, more prominent in the juveniles than in the adults; the outer margin is obliquely plicate, with a short distal spine; the hands are subequal, short, stout, naked, with the surface polished and lightly punctate; inner margin smooth, outer margin with a deep, distinct sinus paralleling the margin from base to near the blunt tip of pollex; fingers of major hand gaping, of minor hand not gaping; pollices of both hands bidentate near their inner apices, more noticeable in the minor chela.

Ambulatory legs heavy, with scattered setae, sparse on merus, more plentiful on carpus and propodus; dactyli long, curving at corneous tip, the underside with a row of three short, straight spines. Telson of abdomen with five plates.

Sexual Variation: The carapace of the females is broader than that of the males.

Color in Life: Ground color of carapace and chelipeds carmine (Ridgway Color Standards). The carapace has distinctive white spots on the shoulders and smaller spots on the lunets opposite the cardiac region. The finger tips of the hands are white, as are the proximal upper ends of the meri of the ambulatories.

Measurements: Female neotype, length of carapace 5.8 mm., width 6.7 mm. Male allotype, length 5.5 mm., width 5.5 mm.

Range: From the Gulf of California to the Galápagos Islands. In the Gulf of California, this species has been taken only at the lower end of the peninsula of Lower California, up to 24° N. Lat.

Material Examined: A series of 17 specimens (Cat. Nos. 36,811, 36,821, and 36,822), 7 males and 10 females, collected by William Beebe off Arena Bank, Lower California, Mexico (Station 136 D-33), May 2, 1936, in 2½ fathoms, in coral (*Pocillopora ligulata*). The neotype and allotype were selected from this series. Through the kindness of the New York Zoological Society, I also examined the type specimens of *Pisosoma aphrodita* Boone, and find them to be conspecific. Hence I have suppressed the latter name as a synonym.

Habitat: Found under coral and sponge-incrusted stones from mean low tide to a depth of 3 fathoms.

Remarks: This unique species may be instantly recognized by its vivid coloring. I know of no other species in the genus with the inner carpal margin so smooth. The specimens taken in the Gulf of California are not incrusted with extraneous matter as are those reported by Boone from the Galápagos.

Pachycheles marcortezensis Glassell.

Pachycheles marcortezensis Glassell, *Trans. San Diego Soc. Nat. Hist.*, vol. 8, no. 21, 1936, p. 290 (type-locality, SE. end of Angel de la Guardia Island, Gulf of California, Mexico).

General Range: Previously recorded only from the type-locality, in 20 fathoms.

Local Distribution: A male and a female (Cat. No. 36,807) were taken from Arena Bank (Station 136 D-23) at a depth of 40 fathoms, on a bottom composed of mud and shells.

Sex and Size: Of the two specimens taken the female measures: length of carapace 4.5 mm., width 5 mm.; the measurements of the male are, length 4.8 mm., width 5 mm.

Color in Alcohol: Red mottled with white, the bristles a straw color.

Habits, Habitat: This species frequents a rather rough bottom, where it is able to secure shelter.

Remarks: This is an extension of geographic range, being a new locality record several hundred miles from the type-locality. It is also an extension of bathymetric range from 20 to 40 fathoms.

Pachycheles sonorensis Glassell.

Pachycheles sonorensis Glassell, *Trans. San Diego Soc. Nat. Hist.*, vol. 8, no. 21, 1936, p. 291 (type-locality, Miramar Bay, near Guaymas, Sonora, Mexico).

General Range: Gulf of California. Low tide to 2½ fathoms.

Local Distribution: A total of 9 specimens (Cat. No. 36,809) was taken off Arena Bank (Station 136 D-33) in coral (*Pocillopora ligulata*) at a depth of 2½ fathoms.

Sex and Size: The collection numbers 3 males and 6 females. The largest specimen, a female, has the following measurements: length of carapace 7 mm., width 7.5 mm.

Color in Alcohol: The ground color of this species is a pink-tinted cream overlaid with numerous, small, red, irregular spots; lighter on the ventral side, but still spotted.

Habits, Habitat: Like most of the members of the genus *Pachycheles*, they are sluggish in their movements. They seek shelter on a moss-, sponge- and coral-incrusted bottom.

Remarks: This is a new locality record for this species, extending its range several hundred miles. The finding of these at a depth of 2½ fathoms also indicates that the natural habitat is subtidal, which accounts in a great measure for the species having been overlooked at other collecting stations in the Gulf of California by previous expeditions.

Genus *Porcellana* Lamarck, restricted Stimpson.

Porcellana cancrisocialis Glassell.

Porcellana cancrisocialis Glassell, *Trans. San Diego Soc. Nat. Hist.*, vol. 8, no. 21, 1936, p. 292 (type-locality, Punta Peñasco, Sonora, Mexico).

General Range: Gulf of California to Magdalena Bay, Lower California.

Local Distribution: 2 young males (Cat. Nos. 36,804 and 36,805) were taken from Arena Bank (Station 136, D-5 and D-6, respectively) at depths of 33 and 35 fathoms, on sandy bottoms with weed.

Color: This species in life is very colorful; the colors in alcohol are fugitive. In life the ground color is an ivory yellow, overcast with lavender and blood-red spots; the ambulatories have their propodi banded with white.

Habits, Habitat: It is commensal in habit, having been found living with a large hermit crab. In this, however, it no doubt is not restricted to a single species of host.

Remarks: While not an extension of geographic range this recording is a considerable extension of bathymetric range, from the inter-tidal zone to a depth of 35 fathoms.

Porcellana paguriconviva Glassell.

Porcellana paguriconviva Glassell, *Trans. San Diego Soc. Nat. Hist.*, vol. 8, no. 21, 1936, p. 293 (type-locality, Punta Peñasco, Sonora, Mexico.)

General Range: Gulf of California.

Local Distribution: A single male (Cat. No. 36,813) was taken from Santa Inez Bay (Station 141 D-2) at a depth between 10 and 15 fathoms, on a bottom composed of muddy sand and crushed shell.

Sex and Size: A male, uncalcified, with the following dimensions: length of carapace 5 mm., width 4.8 mm. The specimen shows distortion, due to its soft state.

Color in Life: This species, like *P. cancrisocialis* Glassell, is of very vivid coloration; ground color, in longitudinal stripes, a bright lavender, a uniform design of bright orange overlaid on this; chelipeds same as carapace, but not patterned; legs with a white spot on propodus. Ventral side iridescent, with longitudinal pattern of carapace continued on first three segments of abdomen.

Habits: This species is commensal with a large hermit crab.

Remarks: This records a new locality record for this species, and also indicates that the species is not strictly an inter-tidal form, in this instance having been collected at a depth of 10 to 15 fathoms.

Porcellana hancocki Glassell, manuscript name.

Material: A total of 3 specimens was taken from Arena Bank (Station 136), and Santa Inez Bay (Stations 142 and 146), between 35 and 40 fathoms on muddy and sandy bottoms.

The specimens were distributed as follows:

Station 136: D-18 (1 male); 40 fathoms; (Cat. No. 36,806).
Station 142: D-3 (1 male); 40 fathoms; (Cat. No. 36,814).
Station 146: D-1 (1 female); 35 fathoms; (Cat. No. 36,923).

EXPLANATION OF PLATE.

PLATE I.

Fig. 1. ***Petrolisthes polymitus***, **male holotype, length 5 mm., dorsal view.**
Fig. 2. ***Pisosoma flagraciliata***, **female holotype, length 4.9 mm., dorsal view.**

FIG. 1.

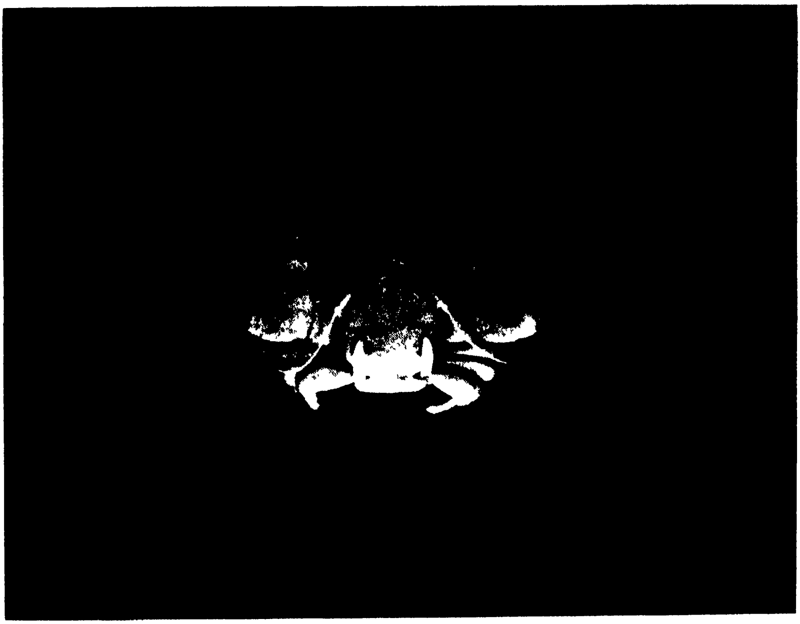


FIG. 2.

PORCELLANID CRABS FROM THE GULF OF CALIFORNIA.

5.

The Templeton Crocker Expedition. V. A New Chrysomelid Beetle of the Genus *Monoxia* from Lower California.[1]

DORIS H. BLAKE

Collaborator, Bureau of Entomology & Plant Quarantine, U. S. Dep't. Agriculture.

(Text-figure 1).

[This is the fifth of a series of papers relating to the collections made by the Templeton Crocker Expedition to Lower California and Clarion Island. Full details, maps, etc., will be found in *Zoologica*, Vol. XXII, No. 2, pp. 33 to 46.]

During the Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society on board the yacht *Zaca,* the following new species of beetle was taken by Dr. William Beebe.

Monoxia beebei sp. nov.

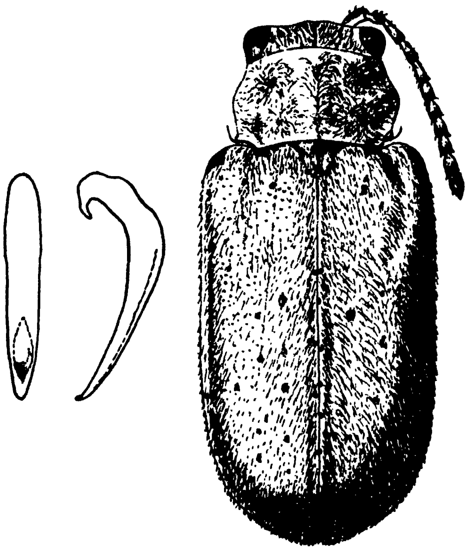
Types: Type male and 4 paratypes, U. S. National Museum, Cat. No. 51941; 4 paratypes in the American Museum of Natural History; 2 paratypes in the collections of the Department of Tropical Research, New York Zoological Society, Nos. 36,925 and 36,926; all collected by William Beebe on April 10, 1936. Of the 11 specimens of the species collected, only 2 are males, both of which had been dissected before the material was given to the writer for examination. It has consequently been necessary to designate as type one of these dissected specimens.

Type Locality: Santa Inez Island, in Santa Inez Bay, Gulf of California (27° 02′ N., 111° 44′ 40″ W.).

Description: Oblong oval, about 3.5 mm. long, pale yellow, sometimes entirely immaculate, but often with small brown elytral spots irregularly placed, and in darker specimens with the underside deeper brown in places; densely covered with silky pale pubescence, the fine, dense elytral punctation more or less visible beneath. *Head* pale with reddish brown mouthparts and in one instance brown frontal tubercles, a median line extending from occiput down front, area above tubercles thickly covered with closely appressed pubescence, lower front less densely hairy. Antennae not extending much below humeri, pale, first and third joints longest, sixth to apical joints thicker. *Prothorax* approximately one and two-thirds times as wide as long, widest in middle where it is somewhat angulate; a nodule at the sharp basal angle; disc slightly depressed on the sides and with a median channel; pubescence dense. *Elytra* moderately convex, wider than prothorax with prominent humeri and a long intrahumeral depression extending about one-third the length of the elytra and curving inwards; in some specimens

[1] Contribution No. 523, Department of Tropical Research, New York Zoological Society.

traces of two median ridges, such as occur in species of *Galerucella;* pubescence dense and recumbent, but not entirely obscuring the close, fine and deep punctation below; markings variable, some specimens entirely pale, others with numerous small brown spots, these spots tending to be along suture and in a series of three or more lines on each elytron. Body beneath densely pubescent; in pale specimens entirely pale, in more heavily marked specimens deeper brown and one specimen with traces of a dark ring about the femora. Claws typical of the genus, simple in female and cleft in male. Length 3.2 to 3.8 mm.; width 1.5 mm.



Text-figure 1.
Monoxia beebei **sp. nov.**

Food-plant: Probably breeding on *Atriplex barclayana* (Benth.) Dietr. or *Amaranthus watsoni* Standl., the two plants making up almost exclusively the vegetation of Santa Inez Island.

Remarks: The species of the genus *Monoxia* are among the most difficult to identify in the Chrysomelidae of this country. In all the collections that I have examined, LeConte's species have been recognized in only one or two instances. Yet LeConte's species, for the most part wrongly synonymized by Horn, have quite distinctive characters to be seen in their shape, their pubescence and punctation, and in the aedeagus. Before any new ones are described, the species already described should be more clearly understood. In a later publication I hope to be able to discuss these species more in detail.

Monoxia beebei is a little smaller than *M. consputa,* a little larger than *M. sordida,* and considerably smaller than *M. angularis* and *M. guttulata,* the largest of LeConte's species. It differs from *consputa* in being narrower and much more densely pubescent and with finer elytral punctation. The aedeagus is also much longer. Besides being smaller than *angularis,* it has a quite differently shaped and narrower prothorax and much finer elytral punctation. In *guttulata* the elytral pubescence is erectish, not recumbent as in this species. *M. obtusa* (including *debilis,* the male of the same species) is a larger and more convex species with deep, well spaced elytral

punctation. *Sordida* belongs to an entirely different group that forms a link between *Galerucella* and *Monoxia*, having the claws in both sexes bifid and having a wider prothorax. *M. batisia* Blatch., occurring on *Batis maritima* from North Carolina to Mexico on the Atlantic coast, is a larger species. The species above referred to include all those hitherto described in the genus.

Dr. Beebe writes: "There were thousands upon thousands of the beetles everywhere, covering decayed sargassum seaweed stranded on the beach as well as the rocks and the above food plants (*Amaranthus* and *Atriplex*). Tens of thousands were flying and resting, covering one's face and clothing in myriads, and they formed the food of lizards, birds, fish, crabs, etc."

6.

A New Species of *Caulolatilus* from Trinidad, British West Indies.[1]

WILLIAM BEEBE
&
JOHN TEE-VAN
Department of Tropical Research, New York Zoological Society.

(Text-figure 1).

During the 22nd Expedition of the Department of Tropical Research, while we were guests of Dr. and Mrs. Henry D. Lloyd on board their yacht *Hardi Biaou,* six days were spent at Port-of-Spain, Trinidad. While we were there, Mr. P. Lechmere Guppy, who is at work on a volume on the fishes of Trinidad, presented us with the specimen upon which the following new species is based. We would like to thank Mr. Guppy for this and many other courtesies during our visit.

BRANCHIOSTEGIDAE.

Caulolatilus guppyi, sp. nov.

TYPE: No. 24,737, Department of Tropical Research, New York Zoological Society, Port-of-Spain Market, Trinidad, British West Indies, December 16, 1936. Standard length 295 mm.

DESCRIPTION: Body considerably compressed, the greatest width of body 7.3 in the length; depth 3.2; anterior profile of head conspicuously and rather sharply rounded. Caudal peduncle deep, its depth 9.5 in the length, much compressed.

Body, except for the snout and chin, covered with scales, those on the breast smaller than the others. Eleven rows of scales from lateral line to beginning of dorsal fin; 88 to 89 rows of scales in a lateral series from shoulder girdle to base of caudal fin; 26 rows from lateral line to origin of anal fin. Lateral line continuous, wavy and not well marked.

Head 3.4 in the length; preopercle slightly serrated, the serrations subequal, the posterior edge almost vertical, the angle rounded; opercular margin with a flat, broadly rounded posterior lobe. Snout 2.7 in head. Eye large, 4.1 in head; interorbital space 3.6 in head. Nostrils small, placed in a horizontal series slightly below the middle of the eye, the posterior a horizontal slit situated 1/3 an eye diameter in front of the eye, the anterior a simple circular hole. Maxillary 2.6 in head, extending posteriorly to the vertical of the anterior margin of the pupil. Teeth in jaws small but strong, curved slightly inward. Lower jaw with multiple rows

[1] Contribution No. 524, Department of Tropical Research, New York Zoological Society.

anteriorly, changing to two rows posteriorly and on the posterior quarter of the jaw to a single ill-defined row; the outer row of teeth considerably larger and stronger than the others, the posterior ones especially so. Upper jaw similar to the lower but the multiple rows of teeth extending farther back and the teeth as a whole not quite as strong. Posteriorly the upper jaw has a single enlarged canine. Teeth absent on the vomer and palatines.

Branchiostegal membranes connected with each other and free from the isthmus. Gill-rakers short, 8 plus 11 on the first gill arch.

Dorsal fin VII, 24, the spines shorter than the rays and increasing in height as they progress backward. Height of second dorsal ray 2.35 in head.

Anal fin I, 22.

Caudal fin square-cut posteriorly with the upper and lower lobes excerted (Tips of the fin now broken off).

Pectoral fin 1.1 in length of head, the upper portion of the fin somewhat falcate.

Pelvic fin origin immediately below that of the pectoral, the length of the longest pelvic ray 1.67 in the length of the head.

Text-figure 1.

Caulolatilus guppyi. Photograph of the type specimen; standard length 295 mm. The tips of the caudal fin broken off in this illustration. Photograph by Edward Osterndorff.

COLOR: (Specimen preserved in rum for several months). Silvery gray, paler below; entire upper sides with brownish reticulations, the brown lines from ½ to ¾ of a scale in width. Snout and interorbital space dark brown. A dark brown band from anterior part of eye to center of mandible on each side, the band a little more than 1/3 an eye diameter in width. Posterior upper part of maxillary dark brown. Pectoral, pelvic and anal fins colorless. Dorsal fin with a median horizontal broken band of brown spots, the fin basally with a series of similar colored spots between each spine and ray. Center of caudal fin mottled brown and white. A large dusky spot at axil of the pectoral fin.

REMARKS: This species differs from the previously described western Atlantic forms of *Caulolatilus, C. chrysops* (Cuvier and Valenciennes) 1833; *C. cyanops* Poey, 1866; *C. microps* Goode and Bean, 1878 and *C. intermedius* Rivero, 1936, in possessing 88 or 89 horizontal rows of scales beneath the lateral line from the shoulder girdle to the base of the tail, as opposed to 105 to 120 in the other species. This count has been carefully verified in the type specimen. The tail in *C. guppyi* is square posteriorly with slightly excerted tips, quite different from the crescentic tail shown in illustrations of the other West Indian forms.

The species is named in honor of Mr. P. Lechmere Guppy of Port-of-Spain, who first collected and recognized the fish as new to the fauna of Trinidad, and who has done so much for the natural history of that island and of Tobago.

Known only from the type specimen.

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7.

The Templeton Crocker Expedition. VI. Oxystomatous and Dromiaceous Crabs from the Gulf of California and the West Coast of Lower California.[1]

JOCELYN CRANE.
Technical Associate, Department of Tropical Research, New York Zoological Society.

(Plates I & II).

[Note: This is the sixth of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica*, No. 2, pp. 33 to 46.]

CONTENTS.

[1] Contribution No. 525, Department of Tropical Research, New York Zoological Society.

INTRODUCTION.

The present paper records the oxystomatous and dromiaceous crabs taken by the Templeton Crocker Expedition with the exception of the specimens taken at Clarion Island. The collection is largely composed of little known species, the majority of the 17 forms having been reported two or three times at most and five having been known previously only from the type specimen. Observations on color in life, food notes and egg counts are included in many instances.

The catalogue numbers all refer to specimens in the collections of the Department of Tropical Research of the New York Zoological Society.

I wish to express my thanks to Dr. Fenner A. Chace, Jr., for comparing specimens of *Osachila lata* with the holotype in the Museum of Comparative Zoology, to Dr. C. R. Shoemaker for facilitating my comparisons of certain specimens with material in the United States National Museum and to Mrs. Ruth Needham Nauss for making the photographs.

SUBTRIBE OXYSTOMATA.

Family Calappidae.

Calappa saussurei Rathbun.

Calappa saussurei Rathbun, 1899, *Proc. U. S. Nat. Mus.*, XXI, p. 609, pl. XLI, fig. 6.

General Range: Gulf of California, 26½ to 75 fathoms.

Local Distribution: A total of 514 specimens was taken from Gorda Banks (Station 150), Arena Bank (Station 136) and the Inez area (Stations 142 and 146) between 33 and 75 fathoms, the bottoms ranging from hard sand or pebbles to soft clayey or shelly mud.

Sex and Size: Of the 514 specimens, 19 were ovigerous females measuring from 19.5 to 32.6 mm. in length; 68 were non-ovigerous females, from 16 to 32.5 mm. in length and 18 to 37 mm. in maximum breadth; and 427 were males, from 12 to 33 mm. in length and 13.5 to 38.5 mm. in maximum breadth. It will be seen that if the 388 young males (14 to 18 mm. long) which were taken in one haul were excluded from the count, the females would be more than twice as numerous as the males. Of the females, less than one-fourth carried eggs. The length was always contained 1.1 to 1.23 times in the maximum breadth, there being no sexual or age difference in proportions.

Color: There was a pronounced contrast apparent between the majority of specimens taken on the sandy bottoms of Gorda Banks and Santa Inez Bay and those of the mud bottoms of Arena Bank, the mud bottom specimens being usually the brighter. Typical specimens from sandy bottoms were colored as follows: Carapace violet brown or tan anteriorly, fading posteriorly to white; all tubercles of carapace bright orange; chelipeds tan, the tubercles orange and white; ambulatories white banded at the joints with pale tan. Most of the specimens from muddy bottoms, on the other

hand, had the entire carapace and sometimes the legs suffused with bright coral red or orange, while the tubercles were usually distinctly coral pink rather than orange. In both groups, the brightest color of all was often concentrated at the bases of a few scattered tubercles. There was considerable variation even among specimens taken in the same haul, the young being in general paler than the adults. Eggs coral red to vermilion.

Food: 12 stomachs were examined from specimens of assorted sizes, both sexes and all three dredging areas. Of these, eight held remains of very small barnacles, usually a single barnacle in a stomach; two contained annelid worms about 10 mm. in length; and two were empty. In two of the stomachs containing barnacles there were traces of sand.

Breeding: Ovigerous females were taken only on Arena Bank. The eggs of six specimens numbered from 4,500 to 7,200, and measured .32 mm. in diameter.

Habits: Live specimens placed on mud in an aquarium and covered with several inches of water lived for four days. The crabs spent almost the entire time completely buried except for the tip of the rostrum, emerging for brief periods late at night. At these times they supported themselves on the very tips of their dactyls on the surface of the soft mud.

Remarks: This crab was previously known only from the type specimen, a male 20.5 mm. long, and one other young specimen, both from the southern part of the Gulf, from 26.5 and 40 fathoms respectively. The present series agrees perfectly with these known specimens except as follows: (1) In a few specimens, the widest part of the body is at the penultimate instead of the antepenultimate tooth of the lateral margin—i.e., at the fourth instead of the third branchial tooth. (2) In small specimens, the first two branchial teeth are scarcely distinguishable from the anterior marginal tubercles. (3) There is variation in the amount of granulation on the carapace.

Material: *Station* 136: D-1 (1 ♀), D-2 (3 ♀, 1 ♂), D-4 (5 ♀, 3 ♂), D-7 (1 ♀, 4 ♂), D-9 (2 ♀, 2 ♂), D-13 (1 ♂), D-14 (10 ♀, 2 ♂), D-15 (4 ♂), D-16 (16 ♀, 1 ♂), D-17 (7 ♀, 2 ♂), D-18 (5 ♀, 4 ♂), D-20 (4 ♀, 1 ♂), D-21 (5 ♀), D-22 (19 ♀, 3 ♂), D-26 (1 ♀). *Station* 142: D-2 (1 ♂), D-3 (5 ♀, 1 ♂). *Station* 146: D-1 (1 ♂). *Station* 150: D-2 (1 ♂), D-3 (1 ♂), D-4 (1 ♀, 1 ♂), D-8 (5 ♂), D-12 (2 ♀, 388 young ♂). Of these specimens, 36 were preserved under Cat. Nos. 36,741, 36,742, 36,818 and 36,819.

Mursia gaudichaudii (Milne Edwards).

Platymera gaudichaudii Milne Edwards, 1837, Hist. Nat. Crust., II, p. 108.

Mursia gaudichaudii, Schmitt, 1921, Marine Decapod Crustacea of California, p. 190, fig. 118.

General Range: Eastern Pacific, from the Farallon Islands, California, to Chile; 26 to 218 fathoms.

Local Distribution: A total of 203 specimens was taken off Cedros Island (Station 126), off Cape San Lucas (Station 151), on Gorda Banks (Station 150) and Arena Bank (Station 136) between 38 and 80 fathoms. The species was most abundant between 60 and 80 fathoms on hard sandy bottoms, although it was taken sparingly on mud and mud-and-crushed-shell bottoms.

Sex and Size: The specimens were almost equally divided between the sexes, about one-third of the females being ovigerous. Females of the latter group measured from 26 to 35.5 mm. in length, non-ovigerous females from 13.5 to 32 mm. and males from 14 to 56.5 mm. The length is contained in the maximum breadth (including lateral spines) about twice in the young and in all males and from 1.7 to 1.9 times in adult females. The

length is contained in the breadth measured between the anterior bases of the lateral spines 1.35 to 1.45 times in the young and in females and about 1.6 times in adult males. Therefore adult males have slightly broader bodies and longer spines than females and young.

Color in Life: Carapace and outer surface of chelipeds apricot buff (usual color) to pale crimson, the tubercles and spines often brighter, ranging from orange to scarlet. Inner surface of merus brilliant scarlet—at least the distal portion—in both sexes. Chelae white. Legs same general color as body, but paler; tips of dactyls horn-colored in adults. Ventral surface white to pale buff.

Food: 12 stomachs were examined with the following results: 4 held chaetognaths; 1, a clam-like mollusk .65 mm. in length; 1, a shrimp; 1, an anemone; 1, fragments of sea urchin test; 2, sand; 2, empty.

Breeding: The ovigerous females carried approximately 18,000 to 20,000 eggs measuring .32 to .38 mm. in diameter.

Material: *Station* 126: D-1 (1 ♂), D-11 (1 ♀). *Station* 136: D-7 (1 ♀), D-9 (1 ♀), D-20 (2 ♀, 1 ♂), D-21, (1 ♂), D-28 (2 ♂). *Station* 150: D-2 (20 ♀, 5 ♂), D-3 (2 ♀), D-4 (6 ♀, 1 ♂), D-6 (23 ♀, 19 ♂), D-12 (7 ♀, 3 ♂), D-13 (2 ♀, 8 ♂), D-14 (28 ♀, 28 ♂), D-15 (1 ♀, 2 ♂), D-17 (4 ♂), D-18 (6 ♂), D-22 (2 ♂), D-23 (1 ♀), D-24 (5 ♀, 12 ♂), D-25 (1 ♀), D-26 (6 ♂). *Station* 151: D-1 (1 ♂). Cat. Nos. 36,816, 36,817, 36,743, 36,744.

Cycloes bairdii Stimpson.

Cycloes bairdii Stimpson, 1860, *Ann. Lyc. Nat. Hist. N. Y.*, VII, no. 2, p. 237.

Cycloes bairdii, Rathbun, 1933, Brachyuran Crabs of Porto Rico and the Virgin Islands, p. 101, fig. 98.

General Range: Pacific, from the southern part of Gulf of California to Panama; Atlantic from North Carolina to Gulf of Mexico and West Indies. To a depth of 33 fathoms.

Local Distribution: A total of eight specimens was taken from San Lucas Bay (Station 135) and Arena Bank (Station 136) between 3 and 33 fathoms on sandy bottoms.

Sex and Size: The single, non-ovigerous female measures 29 mm. in length by 29 in breadth. The seven males range from 6 mm. long by 6.5 mm. wide to 21 mm. long by 21 mm. wide.

Food: Of the three stomachs examined, one contained a barnacle, and two held worms and their sand tubes.

Remarks: Stimpson remarked that adult specimens (larger than those in the present collection) were slightly broader than long, while the young were equal in length and breadth. Our youngest specimens are of adult proportions.

Material: *Station* 135: D-1 (2 ♂), D-6 (1 ♂), D-18 (1 ♂), D-20 (1 ♂), D-26 (2 ♂). *Station* 136: D-5 (1 ♀). Cat. Nos. 36,745, 36,745a.

Osachila lata Faxon.

(Plate I, Figures 1-4).

Osachila lata Faxon, 1893, *Bull. Mus. Comp. Zool.*, XXIV, p. 159.

Osachila lata, Faxon, 1895, *Mem. Mus. Comp. Zool.*, XVIII, p. 32, pl. V, figs. 2, 2a, 2b.

General Range: Gulf of California and off Las Tres Marias, west coast of Mexico. From 40 to 80 fathoms.

Local Distribution: A total of eight specimens was taken from Arena Bank (Station 136) and Gorda Banks (Station 150) between 40 and 75 fathoms on muddy and sandy bottoms.

Sex and Size: The series consists of seven males, measuring from 5.2 to 25.5 mm. in length, and a single ovigerous female, 15.5 mm. in length.

Color in Life: Carapace buffy pink to vinaceous purple lined or blotched with purple or terra cotta. Chelae cream colored spotted and streaked with cinnamon brown; remainder of cheliped chestnut orange to purplish. Ambulatories cream colored barred faintly or strongly with chestnut brown. Eggs black (well developed).

Breeding: The female carried about 1,050 eggs measuring .32 mm. in diameter.

Remarks: Dr. Fenner A. Chace, Jr., kindly compared the present series with the type of the species, the only specimen previously known, at the Museum of Comparative Zoology. As a result of this comparison he has written me, "There is no doubt in my mind that your specimens are referable to *O. lata;* the large male (slightly larger than the type) is so like Faxon's specimen that it could have been easily substituted for the type. Faxon's figures are far from perfect, particularly the one of the mouth parts in which the juncture of the ischium and merus of the outer maxillipeds is depicted as sharply V-shaped rather than rounded."

There is variation in the amount of granulation of the carapace and of tuberculation and erosion of the mouthparts, abdomen and sternum. In general, the rugosity increases with age except in the case of the lower, outer surfaces of the manus and fixed finger of each cheliped, which are rougher in the young.

Material: *Station* 136: D-1 (1 ♂), D-2 (1 ♂), D-23 (1 ♂), D-26 (3 ♂). *Station* 150: D-16 (1 ♀, 1 ♂). Cat. Nos. 36,746, 36,747.

Hepatus kossmanni Neumann.

(Plate I, Figures 5 & 6).

Hepatus kossmanni Neumann, 1878, *Catalog Pod. Crust. Heidelberger Mus.*, p. 28.

Hepatus kossmanni, Rathbun, 1899, *Proc. U. S. Nat. Mus.*, XXI, p. 610.

General Range: "West coast of America;" Panama Bay; Gulf of California.

Local Distribution: Two specimens (Cat. No. 36,929) were taken off Santa Inez Point, Santa Inez Bay, in a fish trap placed at a depth of 13 fathoms on a bottom composed of finely crushed shell and mud.

Sex and Size: The specimens were male and female (non-ovigerous) measuring, respectively, 90 mm. long by 124 mm. wide and 70 mm. long by 96.5 mm. wide.

Color in Life: Dorsal surface of carapace, outer surfaces of chelipeds, and abdomen light yellow densely covered with irregular, cream-colored spots enclosed by narrow circles of scarlet red. The spots, often almost contiguous, vary greatly in size and shape, ranging from less than 1 mm. to more than 4 mm. in diameter and from perfectly round to irregularly oval in shape, the largest spots being interspersed with small ones. They are smallest and most crowded in the anterior central part of the carapace and largest on the intestinal region and on the abdomen. Sternum covered with dense olive green pubescence. Sides of carapace, inner (anterior) portions of chelipeds and ventral (unexposed) portions of ambulatories creamy white, unspotted.

Remarks: The present specimens were compared with those taken by the *Albatross* in Panama Bay, of which the largest measured only 38 mm.

in length (Neumann's type is recorded as 40 mm. long). Our specimens differ markedly in having the carapace almost perfectly smooth, traces of granulation remaining only anteriorly, and the dorsal tubercles of the young being represented by low mounds. The tubercles of the chelae and abdomen are likewise reduced, but not to such an extent as those of the carapace. The proportions of the carapace and the arrangement of the tubercle rudiments are characteristically those of *H. kossmanni* and not of *H. lineatus* Rathbun, 1899, the holotype of which was also examined.

The trap in which the present specimens were taken was baited with rotten fish and mouldy bread.

Family Leucosiidae.

Ebalia cristata Rathbun.

Ebalia cristata Rathbun, 1899, *Proc. U. S. Nat. Mus.*, XXI, p. 612, pl. xliv, fig. 5.

General Range: Gulf of California. Between 40 and 80 fathoms.

Local Distribution: A total of seven specimens was taken from the Inez area (Station 147) and Gorda Banks (Station 150) between 40 and 80 fathoms on muddy and rocky bottoms.

Sex and Size: The collection contains three young females from 6.2 to 12.2 mm. long, one adult, non-ovigerous female 7.9 mm. long and three males, 7.8 to 10 mm. long. The females differ from the males in having the regions less sharply demarcated, the posterior pair of tubercles blunter, and the small, bead-like tubercles lower and much more homogeneous. The tooth on the sixth abdominal segment is present only in adult males.

Color in Life: Carapace pale buffy brown to salmon orange or pink, sometimes with a white median blotch; granules often darker than rest of carapace; chelipeds and legs spotted, banded or washed with red, orange or brown; ventral surface white with three transverse bands of red, orange or brown across middle portion of abdomen. Males usually brighter than females.

Food: The two stomachs examined both contained chaetognath worms.

Remarks: This species has been known previously only from the type specimen, a male 9.6 mm. in length from Abreojos Point, taken in 48 fathoms. The present series was compared with the type at the United States National Museum.

Material: *Station* 147: D-2 (2 ♀, 1 ♂). *Station* 150: D-8 (1 ♂), D-9 (1 ♀, 1 ♂), D-13 (1 ♀). Cat. Nos. 36,748, 36,820.

Lithadia cumingii Bell.

Lithadia cumingii Bell, 1855, *Trans. Linn. Soc. London,* XXI, p. 305, pl. XXXIII, figs. 6, 7.

Lithadia cumingii, Rathbun, 1899, *Proc. U. S. Nat. Mus.*, XXI, p. 613.

General Range: Magdalena Bay and Gulf of California to Costa Rica.

Local Distribution: A young female (Cat. No. 36,930), 7.7 mm. in length, was taken on Arena Bank (Station 136: D-5) at a depth of 33 fathoms on a sandy bottom with abundant weed.

Remarks: The specimen when compared with the young Magdalena Bay female of approximately the same length at the United States National Museum agreed very well, except that the tubercles on the highest portions of the carapace were not quite so prominent.

Lithadia digueti Bouvier.

(Plate II, Figures 7-11).

Lithadia digueti E. L. Bouvier, 1898, *Bull. de la Société Entomologique de France,* Séance du 23 novembre, 1898, p. 330.

General Range: Gulf of California.

Local Distribution: A total of three specimens was taken from Arena Bank (Station 136) and the Inez area (Station 142) between 30 and 35 fathoms on sandy bottoms with crushed shell and weed.

Sex and Size: The two non-ovigerous females both measure 19 mm. in length and 18 mm. in breadth; they are apparently fully adult. The male is 15 mm. long by 13 mm. wide.

Color in Life (Specimens from Santa Inez Bay): Carapace pinkish gray to deep coral pink with spots or bars of dark coral red or maroon in the following positions: On the exterior margin of the postocular depression, on proto-gastric ridge, on summits of hepatic and branchial tubercles, at anterior junction of the two branchial orifices, on posterior-lateral tubercles and in the sutures between branchial and intestinal regions; pink speckles on small branchial tubercles and inside branchial orifices; all legs usually pale pink barred or spotted with deep coral red or maroon; chelae plain pale pink; two transverse stripes of coral red or maroon across abdomen in both sexes.

Remarks: This strangely formed species has been known previously only from the male holotype, a specimen 14.5 mm. long by 12.2 wide taken in the Gulf of California, the depth and the exact locality not being specified. Our specimens agree excellently with the description of the type. The females differ from the male in the relative bluntness of the protuberances on the posterior half of the carapace. When laid on coarse sand or crushed shell, these crabs closely resembled pinkish nodules, formed of calcareous algae (*Melobesia*) and bryozoans, which were very common in the same nets.

Material: *Station* 136: D-30 (1 ♀). *Station* 142: D-1 (1 ♀), D-2 (1 ♂). Cat. Nos. 36,749, 36,821.

Randallia americana (Rathbun).

Ebalia americana Rathbun, 1893, *Proc. U. S. Nat. Mus.,* XIV, p. 254.

Randallia americana, Rathbun, 1899, *Proc. U. S. Nat. Mus.,* XXI, p. 614.

General Range: Gulf of California. From 9.5 to 71 fathoms.

Local Distribution: 49 specimens were taken from the Inez area (Stations 141, 142, 143, 146 and 147) between 18 and 60 fathoms on muddy and sandy bottoms, both types usually having an abundance of crushed shell.

Sex and Size: The collection is composed of 17 non-ovigerous females between 3.4 and 12 mm. in length (measured in the longitudinal mid-line, so that the posterior spines are excluded), 1 ovigerous female 9.2 mm. long and 31 males between 5.2 and 12.4 mm. in length.

Color in Life: Pale buff to salmon orange, the chelipeds and ambulatories often washed or banded with scarlet, orange or brown. Sometimes the larger tubercles or granules of the carapace were the same color, as well as the boundaries of some or all of the regions of the carapace.

Food: Six stomachs from four different stations all contained bottom detritus (including Foraminifera) and worms.

Enemies: Remains of young examples of this species were found in the stomachs both of *Iliacantha schmitti* and of *Dasygyius depressus* taken at these stations.

Breeding: The ovigerous female carried about 850 eggs .27 mm. in diameter.

Remarks: The males in the present series agree perfectly with the original description. Females have the posterior paired tubercles much less prominent and more widely spaced; likewise, the intestinal tubercle is less pointed. These sexual differences are notable, though to a less marked degree, even in the very young, while the male chelipeds are not elongated until the very last moults. The present specimens were compared with the type material in the United States National Museum.

Material: *Station* 141: D-4 (1 ♀, 4 ♂). *Station* 142: D-1 (1 ♀, 3 ♂), D-2 (3 ♀, 5 ♂), D-3 (1 ♀), D-4 (1 ♀, 2 ♂). *Station* 143: D-1 (4 ♂), D-2 (3 ♀, 2 ♂), D-3 (1 ♀, 1 ♂), D-5 (1 ♂). *Station* 146: D-1 (6 ♀, 7 ♂). *Station* 147: D-2 (1 ♀, 2 ♂). Cat. Nos. 36,826, 36,827, 36,828.

Persephona townsendi (Rathbun).

Myra townsendi Rathbun, 1893, *Proc. U. S. Nat. Mus.*, XVI, p. 255.

Persephona townsendi, Rathbun, 1899, *Proc. U. S. Nat. Mus.*, XXI, p. 613.

General Range: Gulf of California. From 20 to 58 fathoms.

Local Distribution: A single male (Cat. No. 36,823), measuring 16 mm. long (excluding spines) and 14 mm. wide, was taken in the Inez area (Station 143 D-2) at a depth of 30 fathoms on a bottom composed of finely crushed shell and mud.

Remarks: The present specimen was compared with the group at the United States National Museum.

Iliacantha schmitti Rathbun.

Iliacantha schmitti Rathbun, 1935, *Proc. Biol. Soc. Wash.*, XLVIII, p. 2.

General Range: Gorgona Island, Colombia (type specimen) and Gulf of California. From 35 to 150 fathoms.

Local Distribution: A total of 27 specimens was taken from Arena Bank (Station 136) and the Inez area (Stations 142, 146 and 147) between 35 and 60 fathoms on muddy and sandy bottoms, the majority being taken in mud.

Sex and Size: The specimens included 5 ovigerous females measuring from 23 to 35 mm. long (length measured to include rostrum, exclude intestinal and posterior spines), 8 non-ovigerous females 11 to 26 mm. long and 13 males, 12 to 27 mm. long.

Color in Life: Carapace pale apricot buff to brick red, sometimes speckled or streaked with white; a large white spot often present on hepatic region, or a larger patch on the branchial; anterior part of carapace sometimes speckled with maroon; posterior pair of spines sometimes yellow. All legs buff, the upper side of the merus washed with orange or red; chelae and dactyls of ambulatories often bright orange, sometimes brown. Ventral side pale. Eggs wine red to deep purple.

Food: Of eight stomachs examined, two contained remains of young *Randallia americana*, one of shrimp, and one of an indeterminable crustacean; two held bottom detritus and two were empty.

Breeding: A female 23 mm. in length carried about 2,900 eggs measuring .38 mm. in diameter.

Habits: Specimens kept alive for four days in an aquarium remained completely buried in mud in the bottom.

Remarks: Examples of the present series were compared with the

type specimen in the United States National Museum. This species will be fully described and illustrated by Dr. Rathbun in her monograph on the Oxystomatous Crabs, which is now in press.

Material: *Station* 136: D-2 (1 ♂), D-4 (1 ♀), D-17 (1 ♂), D-20 (3 ♀, 1 ♂), D-21 (1 ♂), D-22 (2 ♀), D-23 (1 ♀), D-24 (1 ♂), D-26 (2 ♀, 2 ♂), D-31 (2 ♂). *Station* 142: D-3 (1 ♀). *Station* 146: D-1 (2 ♀, 2 ♂). *Station* 147: D-2 (2 ♀, 2 ♂). Sixteen of these specimens are preserved under Cat. Nos. 36,750, 36,822, 36,824 and 36,825.

Family Dorippidae.

Ethusa lata Rathbun.

Ethusa lata Rathbun, 1893, *Proc. U. S. Nat. Mus.*, XVI, p. 258.

Ethusa lata, Rathbun, 1899, *Proc. U. S. Nat. Mus.*, XXI, p. 615.

General Range: From Cedros Island and the Gulf of California to Panama Bay. From 14 to 66 fathoms.

Local Distribution: A total of five specimens was taken from off Cedros Island (Station 126), from Arena Bank (Station 136), Gorda Banks (Station 150) and the Inez area (Station 143) between 25 and 56 fathoms on muddy, sandy and rocky bottoms.

Sex and Size: The series includes one ovigerous female measuring 14.5 mm. long by 16.5 mm. wide and four males, from 7 mm. long by 7.2 mm. wide to 15.5 mm. long by 17 mm. wide. The second ambulatories of the female measure 30.5 mm. in length, those of the largest male 44 mm.

Color in Life: General color olive buff, the palms and chelae of large males scarlet, the legs of all specimens banded with buff or white and scarlet, or entirely suffused with scarlet.

Food: The specimen taken off Cedros Island had eaten small worms with tubes of sand grains; one from the Inez area held organic detritus, probably a worm.

Breeding: The ovigerous female carried about 4,800 eggs measuring .32 mm. in diameter.

Remarks: The present series was compared with the type specimen at the United States National Museum.

Material: *Station* 126: D-9 (1 ♂). *Station* 136: D-4 (1 ♀), D-9 (1 ♂). *Station* 143: D-4 (1 ♂). *Station* 150: D-9 (1 ♂). Cat. Nos. 36,751, 36,752, 36,830, 36,831.

Ethusa mascarone americana A. Milne Edwards.

Ethusa americana A. Milne Edwards, 1880, *Bull. Mus. Comp. Zool.*, VIII, p. 30.

Ethusa mascarona americana, Rathbun, 1933, Brachyuran Crabs of Porto Rico and the Virgin Islands, Scient. Survey of Porto Rico and the Virgin Islands, XV, part 1, p. 105, fig. 102.

General Range: From North Carolina to the Gulf of Mexico and the West Indies; Gulf of California. From 13 to 35 fathoms.

Local Distribution: Two specimens were taken from Arena Bank (Station 136) and the Inez area (Station 142), respectively, from 30 and 35 fathoms on sandy bottoms.

Sex and Size: The non-ovigerous female measured 13 mm. long, the male 6.9 mm. long.

Color in Life: The female (from the Inez area) was deep pink, the carapace mottled and the legs banded with maroon.

Material: *Station* 136: D-30 (1 ♂). *Station* 142: D-1 (1 ♀). Cat. Nos. 36,753, 36,832.

SUBTRIBE DROMIACEA.

Family Dromiidae.

Dromidia larraburei Rathbun.

Dromidia sarraburei Rathbun, 1910, *Proc. U. S. Nat. Mus.*, XXXVIII, p. 553, pl. 48, fig. 4. (Error for *D. larraburei*).

Dromidia larraburei, Schmitt, 1921, The Marine Decapod Crustacea of California, *Univ. of Calif. Publ. in Zool.*, XXIII, p. 183, pl. 33, fig. 1.

General Range: From Monterey Bay, California, to Peru and Galápagos Islands. From shallow water to 45 fathoms.

Local Distribution: Eight specimens were taken on Arena Bank (Station 136) between 40 and 45 fathoms on muddy bottoms.

Sex and Size: The series contains three non-ovigerous females between 12 and 26 mm. long and five males between 5.5 and 12.5 mm. long.

Color in Life: Pubescence yellowish; chelae scarlet.

Food: Three stomachs all held bottom detritus; one had algae in addition.

Remarks: This species has not been taken previously in deep water.

Material: *Station* 136: D-1 (1 ♂), D-13 (1 ♀, 1 ♂), D-23 (2 ♀, 3 ♂). Cat. No. 36,754.

Hypoconcha californiensis Bouvier.

Hypoconcha californiensis Bouvier, 1898, *Bull. de Musée de Nat. Hist. de Paris*, IV, pp. 374-375.

General Range: Gulf of California. To a depth of 35 fathoms.

Local Distribution: Two non-ovigerous females (Cat. No. 36,756), each measuring 8 mm. long by 8 mm. wide, were taken on Arena Bank (Station 136 D-30) at a depth of 35 fathoms on a sandy bottom with abundant weed.

Remarks: This species has been known previously only from the two original females, the intact, smaller specimen having measured 12.5 mm. in length. The present specimens agree perfectly with the description except that there are two, not three, large teeth on each frontal lobe and five, not six, on the antero-lateral margin of the carapace.

Hypoconcha digueti Bouvier.

Hypoconcha digueti Bouvier, 1898, *Bull. du Musée de Nat. Hist. de Paris*, IV, pp. 374, 376.

Hypoconcha digueti, Rathbun, 1923, *Bull. Amer. Mus. Nat. Hist.* XLVIII, p. 620.

General Range: Gulf of California.

Local Distribution: Four specimens (Cat. No. 36,755) were taken from Arena Bank (Station 136 D-30) at a depth of 35 fathoms on a sandy bottom with abundant weed.

Sex and Size: The series consists of one ovigerous female, 17.5 mm. long by 18.5 mm. wide, and three non-ovigerous females, two 7.2 mm. long and 7.6 mm. wide. and one 25 mm. long by 26 mm. wide.

Color in Life: Yellowish, tinged and blotched irregularly with pink, especially ventrally; chelae crimson. The type specimen was "uniformly reddish."

Food: Sand and Foraminifera were contained in the stomach of the largest female.

Breeding: The ovigerous female carried about 775 eggs measuring .59 mm. in diameter.

Habits: Two of the specimens carried shells of *Glycymeris maculata* Broderip with apertures exactly matching the size of their carapaces. The type specimen was found under an old *Pecten* shell.

Family Homolidae.

Homola faxoni Schmitt.

Homola faxoni Schmitt, 1921, The Marine Decapod Crustacea of California, *Univ. of Calif. Publ. in Zool.*, XXIII, p. 184, pl. 31, fig. 7.

General Range: Point Loma, California, and west of San José Point, Lower California.

Local Distribution: A single non-ovigerous female (Cat. No. 36,833) was taken off San José Point (Station 175 D-1) at a depth of 45 fathoms on a shaley bottom.

Size: Length with rostrum 16 mm., rostrum 2.7 mm., greatest width (between tips of spines) 14.5 mm., width excluding spines 12 mm., length third ambulatory leg 43.5 mm., length of same to distal extremity of merus 19 mm., length of last ambulatory to distal extremity of propodus 26.5 mm.

Color in Life: Entirely buff, except anterior part of carapace which is suffused with scarlet.

Remarks: This species has been known previously only from the type specimen, a female 45 mm. in length. The present specimen agrees perfectly with the type description except that the posterior (or lower) of the two hooked spines on each supraorbital spine is rudimentary.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Osachila lata* Faxon, male, length 25.5 mm., dorsal view.
Fig. 2. Same, ventral view.
Fig. 3. *Osachila lata* Faxon, female, length 15.5 mm. dorsal view.
Fig. 4. Same, ventral view.
Fig. 5. *Hepatus kossmanni* Neumann, male, length 90 mm., dorsal view.
Fig. 6. *Hepatus kossmanni* Neumann, female, length 70 mm., ventral view.

PLATE II.

Fig. 7. *Lithadia digueti* Bouvier, female, length 19 mm., dorsal view.
Fig. 8. Same, ventral view.
Fig. 9. *Lithadia digueti* Bouvier, male, length 15 mm., dorsal view.
Fig. 10. Same, ventral view.
Fig. 11. Same, posterior view.

FIG. 1.

FIG. 2.

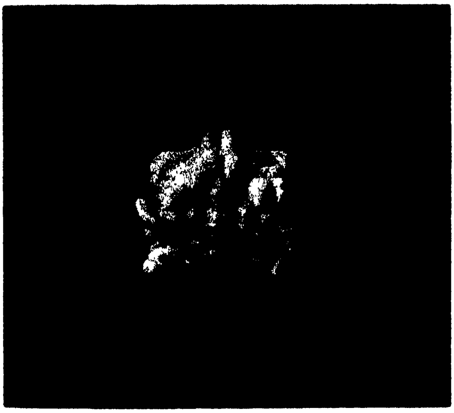

FIG. 3.

FIG. 4.

FIG. 5. FIG. 6.

OXYSTOMATOUS AND DROMIACEOUS CRABS FROM THE GULF OF CALIFORNIA AND THE WEST COAST OF LOWER CALIFORNIA.

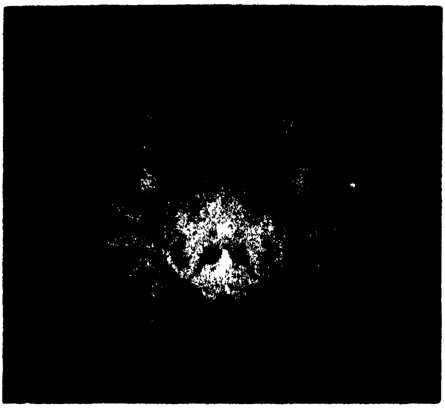

FIG. 7.

FIG. 8.

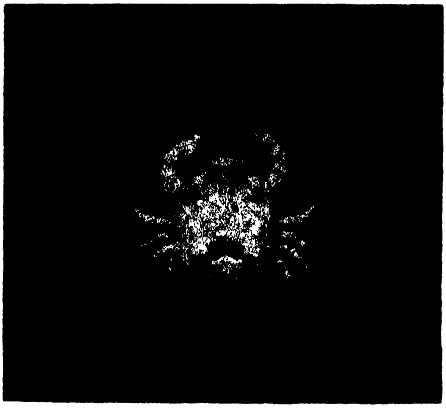

FIG. 9.

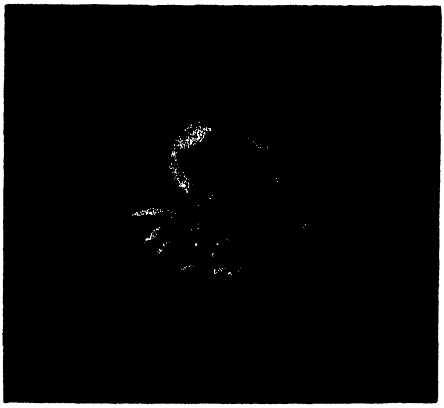

FIG. 10.

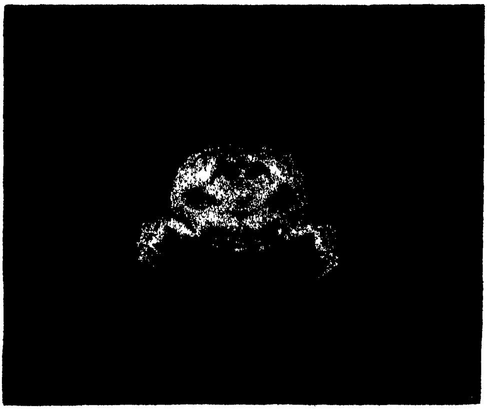

FIG. 11.

OXYSTOMATOUS AND DROMIACEOUS CRABS FROM THE GULF OF CALIFORNIA AND THE WEST COAST OF LOWER CALIFORNIA.

8.

The Templeton Crocker Expedition. VII. Caridean Decapod Crustacea from the Gulf of California and the West Coast of Lower California.[1]

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(Text-figures 1-9).

[Note: This is the seventh of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of the specimens treated in this paper, refer to the present volume of *Zoologica*, No. 2, pp. 33 to 46.]

CONTENTS.

[1] Contribution No. 526, Department of Tropical Research, New York Zoological Society.

INTRODUCTION.

The caridean prawns collected by the Templeton Crocker Expedition belong to 29 species, of which nine were apparently heretofore undescribed and one is the type of a new genus. Worthy of particular mention is the remarkable fact that, of the remaining 20 known species, nine had not been previously recorded from the region visited by the expedition. Of these nine forms, four were entirely unknown to the fauna of the Pacific coast of America; two of the four were described from the tropical Atlantic and the other two are Indo-Pacific varieties. Inasmuch as all three species of Hippolytidae in the collection, including two undescribed species, and one species of Palaemonidae, were well represented in the stomach contents of specimens of the American Eared Grebe (*Colymbus nigricollis californicus* (Heermann)), the suggestion might be advanced that the habits of such diving birds would become of real interest not only to the ornithologist but to the student of marine invertebrates as well if they could be trained to collect such animals much as are the cormorants of oriental fishermen.

The color notes were made in the field by members of the expedition.

All catalogue numbers refer to specimens in the collections of the Department of Tropical Research of the New York Zoological Society, except those preceded by the letters M.C.Z; the latter group denotes specimens in the Museum of Comparative Zoology.

PASIPHAEIDAE.

Pasiphaea emarginata Rathbun.

Pasiphaea emarginata Rathbun, M.J., *Proc. U. S. Nat. Mus.*, vol. 24, p. 905, 1902.

Pasiphaea emarginata Schmitt, W.L., *Univ. California Pub. Zool.*, vol. 23, p. 30, fig. 15, 1921.

General Range: From off Santa Barbara Islands and Santa Barbara Channel to off San Diego, California, and off Cóncepcion Bay, Gulf of California, from 216 to 857 fathoms.

Local Distribution: A total of three specimens was taken 23 miles east by south of Tortuga Island (Station 139) and 13 and 20 miles northeast of San Ildefonso Islands (Station 148) in 500 fathoms.

Sex and Size: The three males have a total length of 39, 45 and 64 mm.; the carapace lengths are respectively 15.2, 18 and 26.4 mm.

Color in Life: Translucent white speckled with fine chromatophores,

scarlet red by Ridgway's Color Standards. The red is most concentrated on the sides of the carapace, on the keel of the last three abdominal segments and on all the appendages. Eye dark brown.

Remarks: The *Zaca* specimens were taken very near the point off Concepcion Bay which is the type locality of this species.

Material: *Station* 139: T-4 (1 ♂). *Station* 148: T-4 (1 ♂), T-8 (1 ♂). Cat. Nos. 36,931, 36,932.

Leptochela serratorbita Bate ?

Leptochela serratorbita Bate, C.S. *Challenger Rept., Zool.*, vol. 24, p. 859, pl. 134, fig. 1, 1888.

Leptochela serratorbita Schmitt, W.L., *Sci. Surv. Porto Rico and Virgin Ids.*, vol. 15, pt. 2, p. 134, 1935.

General Range: Key West, Florida, to St. Thomas, to a depth of 23 fathoms.

Local Distribution: A total of 99 specimens was taken at San Lucas Harbor (Station 135) both at the surface beneath a light and dredged in 8 to 16 fathoms on sandy bottoms.

Sex and Size: The mature female taken on March 29 is ovigerous; it is about 17 mm. long, the carapace measuring 4.1 mm. The female taken with the dredge, which, from the condition of the abdomen, had evidently liberated eggs but a short time before, is of about the same length with a carapace length of 3.9 mm. The young are from 4.9 to 7.7 mm. long.

Remarks: Although these specimens agree very well with Miss Rathbun's description (*Bull. U. S. Fish. Comm.* for 1900, vol. 20, pt. 2, p. 127, 1901), a direct comparison of Atlantic and Pacific specimens might possibly reveal differences of taxonomic importance. The young specimens in the present material lack the row of spines on the orbital margin, but this is probably attributable to their age.

I have had the opportunity to examine two males and a female of this species loaned by the American Museum of Natural History which were taken near Topolobampo, Mexico, Lat. 25° 30′ N., Long. 109° 12′ W. on November 17, 1935.

Material: *Station* 135: Surface night light, March 29 (1 ♀, 97 young), D-1 (1 ♀). Cat. Nos. 36,933, 36,934.

ACANTHEPHYRIDAE.

Acanthephyra curtirostris Wood-Mason.

Acanthephyra curtirostris Wood-Mason, J., *Ann. Mag. Nat. Hist.*, ser. 6 vol. 7, p. 195, 1891.

Acanthephyra curtirostris Balss, H., *Wiss. Ergebn. Deutschen Tiefsee-Exped.*, vol. 20, no. 5, p. 261, text-fig. 30 (mandible), 1925.

General Range: Off the east coast of Africa, Arabian Sea, Bay of Bengal, Laccadive Sea, Andaman Sea, Malay Archipelago, Philippine Islands, south of Japan, Hawaiian Islands and off the west coast of America from San Diego to Peru. There is also a specimen in the U. S. National Museum, which I refer to this species, that was taken in the equatorial Atlantic off British Guiana. *A. curtirostris* has been taken in depths ranging from 364 to 2,730 fathoms.

Local Distribution: A total of 26 specimens was taken from nine miles south of Santa Margarita Island (Station 133), 23 miles east by south of Tortuga Island (Station 139), four and one half miles southwest of Mazatlan (Station 154) and 34 miles east by south of Arena Point (Station 159).

Sex and Size: Three of the females are ovigerous and range in length from 99 to 102 mm. (carapace, 23.7 to 24 mm.). The non-ovigerous females are from 70 to over 86 mm. long (carapace, 17 to 22 mm.), the two males are 73 and 84 mm. long (carapace, 17.2 to 20.2 mm.) and the young vary from 14 to 40 mm. long (carapace, 3.5 to 9.8 mm.).

Material: *Station* 133: T-3 (1 ♂, 2 young). *Station* 139: T-4 (4 ♀, 1 young). *Station* 154: T-4 (2 young). *Station* 159: T-3 (1 ♂, 1 ♀, 14 young). Cat. Nos. 36,935 to 36,939, incl. Two females from *Station* 139 and four young specimens from *Station* 159 are in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M.C.Z. Cat. Nos. 9,508, 9,509).

PANDALIDAE.

Plesionika mexicana, sp. nov.

(Text-figure 1).

Type: Holotype ovigerous female, Cat. No. 36,940, Department of Tropical Research, New York Zoological Society. From Station 136, D-1, Arena Bank, Lat. 23° 29′ N., Long. 109° 25′ W., 45 fathoms, muddy bottom, April 3, 1936.

Diagnosis: Rostrum much longer than antennal scale with 10 to 14 ventral spines and the spines of the basal crest barbed at the tip and all but the most anterior movable. Second pair of legs very unequal. Carpus of three posterior legs much shorter than propodus which is slightly more than three times as long as the dactyl.

Description: The carapace is about two-fifths as long as the abdomen. The posterior half is smoothly rounded, the low carina of the dorsal crest arising slightly in front of the midpoint of the carapace. Arising from the crest are four or five barbed spines, the posterior three or four of which are movable. Two or three of the spines are behind the orbit and they increase in size from the first to the third. The antennal spine is long and slender, about twice as long as the stout branchiostegal spine.

The rostrum is almost twice as long as the carapace. It bends slightly downward in front of the eyes and ascends gradually from that point to the apex. Following the barbed spines at the base of the rostrum there is usually, but not always, a smooth interspace that extends beyond the level of the antennal scale and this is followed by four or five progressively smaller spines, the distal two being placed just back of the tip of the rostrum. On the ventral margin are 10 to 14, usually 13, subequal spines separated by successively longer interspaces.

The abdomen is dorsally smooth and rounded without a carina on any of the somites, although the third is somewhat compressed and forms a distinct angle. There are no teeth or spines on any of the segments with the exception of the spines arming the acute postero-lateral angles of the fourth and fifth pleura. The sixth segment, which is about one and two-thirds as long as the fifth, is also provided with a spine at the corresponding angle. Somewhat shorter than the sum of the two preceding somites, the telson is armed with three pairs of lateral and three pairs of terminal spinules; it is slightly shorter than the inner branch of the uropods.

The large, globular eyes have a distinct but incompletely separated ocellus on the dorsal surface of the stalk.

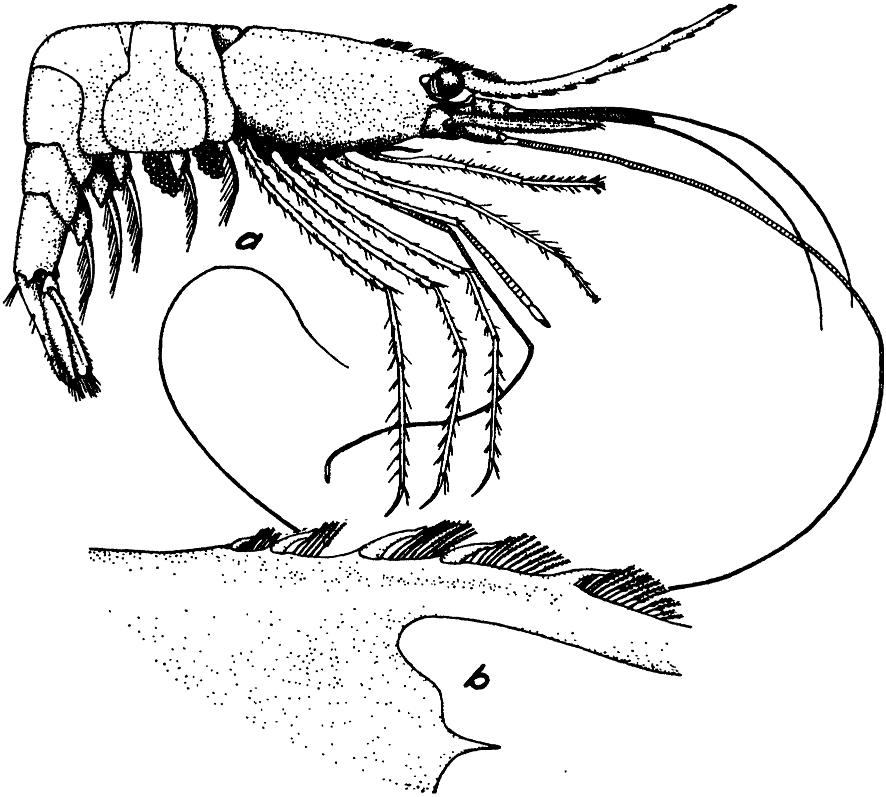
The second and third joints of the antennular peduncle are subequal and the stylocerite slightly exceeds the first segment. The subequal flagella are about half again as long as the rostrum.

The antennal scale is narrow and tapers distally to a truncate tip that is considerably surpassed by the stout outer spine. The antennal flagella are almost twice as long as the animal.

The external maxillipeds are provided with well-developed exopods and project beyond the antennal scale by about one-fifth of the terminal joint. The first pair of legs is as long as the external maxillipeds. The second legs are very unequal, the right extending beyond the antennal scale by no more than the length of the fingers and provided with about 20 carpal segments, the left exceeding the rostrum by almost half the carpus and provided with about 100 carpal segments. The propodi of the last three legs are about one and one-half times the carpi and about three times as long as the dactyls.

The eggs are very small, about 0.3 mm. long, and very numerous.

The holotype is 51 mm. long, of which the carapace measures 9.5 mm., the abdomen 25 mm. and the rostrum 18 mm.



Text-figure 1.

Plesionika mexicana, sp. nov. **a.** Female holotype. **b.** Base of rostrum of holotype.

Local Distribution: A total of 93 specimens was taken from Arena Bank (Station 136), Gorda Banks (Station 150) and three miles east of Cape Falso (Station 151) between 30 and 75 fathoms, on various types of bottoms, including muddy, sandy, shelly and hard.

Sex and Size: All but three of the females are laden with eggs. These specimens have a carapace length of from 6 to 12 mm. The non-ovigerous females give corresponding measurements of 6.3 to 8.6 mm., and the males, from 5 to 11.2 mm. It is of interest that the five males from Station 136 were all very small and it was only in deeper water (65 to 75 fathoms) at Stations 150 and 151 that males were found in abundance and of a size comparable to that of the ovigerous females.

Color in Life: General color translucent white with short, longitudinal stripes, scarlet by Ridgways Color Standards, alternating with areas speckled with opaque white dots. The amounts of scarlet and white are variable, but the general pattern is quite constant, even in specimens taken from various types of bottom; there is a transverse red bar across the carapace immediately behind base of rostral keel, a second on first abdominal segment, a third on third abdominal segment (usually brightest in the males) and a fourth at base of telson; the remainder of scarlet body markings are short, irregular, longitudinal streaks on the abdominal pleura; antennae and periopods barred with scarlet and white; pleopods, uropods and telson streaked longitudinally with scarlet in most individuals, sometimes entirely translucent white. Eyes greenish. Eggs bluish green.

Remarks: The rostral armature is variable in this species, but the holotype represents by far the commonest arrangement. *P. mexicana* is apparently most closely related to *P. binoculus* (Bate), but it differs in its smaller size and less elevated dorsal crest, which is armed with barbed rather than simple spines.

Material: *Station* 136: D-1 (3 ♂, 22 ♀), D-11 (1 ♀), D-24 (2 ♂, 13 ♀), D-26 (1 ♂, 3 ♀). *Station* 150: D-16 (21 ♂, 22 ♀). *Station* 151: D-1 (5 ♂, 1 ♀). Cat. Nos. 36,940 (holotype) and 36,941 to 36,946 inclusive (paratypes). Six male and 12 female paratypes are deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. Nos. 9,491, 9,492, 9,493).

Plesionika beebei, sp. nov.

(Text-figure 2).

Type: Male holotype, Cat. No. 36,948, Department of Tropical Research, New York Zoological Society. From Station 148, T-2, 13 miles northeast by north of San Ildefonso Island, Lat. 26° 48′ 40″ N., Long. 111° 20′ 30″ W., 300 fathoms, April 17, 1936.

Diagnosis: Rostrum much longer than antennal scale, nearly straight, distal third of dorsal surface usually unarmed except for a single sub-apical tooth, ventral surface armed throughout with 10 to 15 teeth. Second pair of legs subequal. Carpus of three posterior legs somewhat shorter than propodus, dactyl of third leg more than half as long as propodus.

Description: The integument is soft and almost membranous.

The carapace is about three-tenths as long as the abdomen. It is compressed on the dorsal mid-line into a low but well-marked carina which bears three or four spines behind the orbit, the first two being movable. Posterior to this crest there is a distinct cervical groove behind which and above the strong supra-branchial ridge is a depressed pubescent area. The antennal is but little longer than the branchiostegal spine.

The rostrum is about twice as long as the antennal scale and ascends very slightly in its distal half. It is armed dorsally, in addition to the three or four spines behind the orbit, with six or seven teeth on the proximal half followed by a smooth interspace and a single small tooth just back of the tip. Ventrally there are 10 to 15 teeth which are largest at the mid-point of the rostrum; they become more distantly spaced anteriorly.

The abdomen is smoothly rounded for the entire length of its dorsal surface. The pleuron of the fourth somite has an acute postero-lateral angle, and that of the fifth is spinose. On the sixth segment, which is two and one-third times as long as the fifth, there is a similar small spine at the postero-lateral angle. The telson is slightly longer than the inner branch of the uropods and is armed with four pairs of dorso-lateral and three pairs of terminal spines.

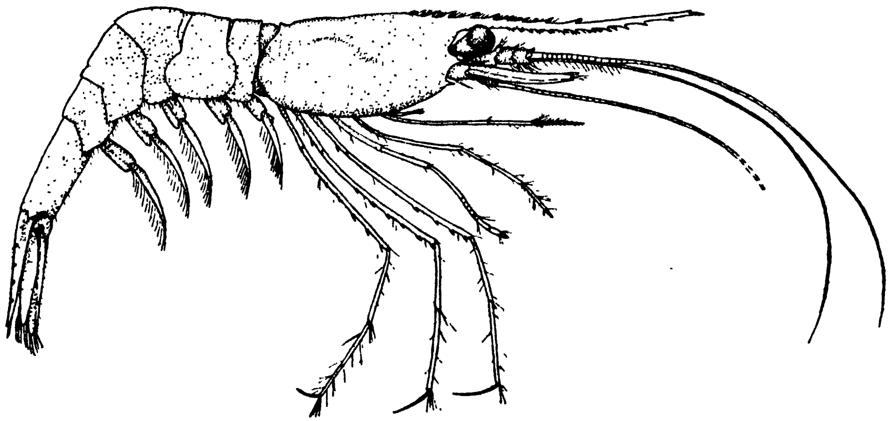
The large, globular eyes have a very small incomplete ocellus on the dorsal surface of the stalk.

The second and third joints of the antennular peduncle are subequal in length and the stylocerite is somewhat shorter than the first joint. The subequal flagella are more than twice as long as the rostrum.

The antennal scale is narrow and tapers slightly to a truncate tip which is exceeded but little by the outer spine.

The external maxillipeds have a well developed exopod and exceed the antennal scale by about one-third of the length of the distal segment. All of the legs are very slender. The first pair reaches nearly as far forward as the external maxillipeds. The second pair are subequal in length and the carpi are made up of eight or nine segments. The third legs extend slightly beyond the tip of the rostrum, the carpus is a little shorter than the propodus and the lanceolate dactyl more than half as long as the propodus. The fourth and fifth legs are similar to the third, except that the dactyl of the fifth pair is less than one-third as long as the propodus.

The holotype is 40 mm. long of which the carapace measures 6 mm., the abdomen 21 mm. and the rostrum 12.3 mm.



Text-figure 2.
Plesionika beebei, sp. nov. Male holotype.

Local Distribution: A total of seven specimens was taken from 23 miles east by south of Tortuga Island (Station 139), 13 to 20 miles northeast of San Ildefonso Island (Station 148) and Gorda Banks (Station 150), between 40 and 500 fathoms.

Sex and Size: Most of the specimens are in poor condition due to the soft integument. None of the females is ovigerous and the condition of the endopod of the first pleopods of the males seems to indicate that these specimens are not fully mature. The males have a carapace length of 6 to 8 mm., and the single unmutilated female 10.7 mm.

Color in Life: A paratype from Station 139 was translucent white, the carapace and abdominal pleura speckled with scarlet, and the uropods and telson entirely scarlet.

Remarks: This species is apparently closely related to *P. ortmanni* Doflein from the western Pacific, but differs in having the carpi of the three posterior legs shorter than the propodi and in having eight rather than more than 30 joints in the carpi of the second legs.

Material: *Station* 139: T-2 (1 ♂). *Station* 148: T-2 (1 ♂), T-6 (1 ♂), T-8 (1 ♂). *Station* 150: D-5 (2 ♀ and 1 carapace). Cat. Nos. 36,948 (holotype); 36,947, 36,949 and 36,950 (paratypes). One male paratype is

deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,494).

Pantomus affinis, sp. nov.

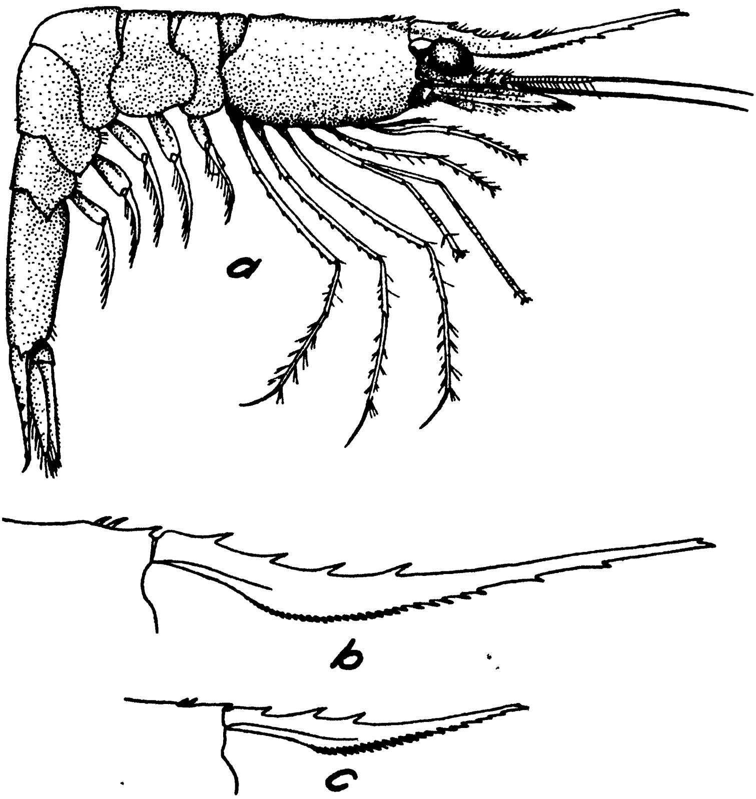
(Text-figure 3).

Type: Male holotype, Cat. No. 36,1052, Department of Tropical Research, New York Zoological Society. From Station 147, D-2, Santa Inez Bay, Lat. 26° 56′ 30″ N., Long. 111° 48′ 30″ W., 60 fathoms, April 17, 1936.

Diagnosis: Five to eight spines on dorsal edge of rostrum anterior to articulation with carapace; 27 to 36 teeth on ventral edge. Four to six, usually five, pairs of dorso-lateral spines on telson not including the pair just above the terminal spinules. Scaphognathite of second maxilla broad.

Description: The carapace is a little more than one-fourth as long as the abdomen, smoothly rounded on the posterior half and anteriorly compressed into a low frontal crest which is armed with two small movable spines and a fixed spine at the articulation with the rostrum. The supra-branchial ridge is clearly defined but not prominent and the antennal spine is perceptibly larger than the branchiostegal.

The rostrum is about three-fourths again as long as the carapace, armed above with four to seven spines on the proximal half and a small spine just



Text-figure 3.

Pantomus affinis, sp. nov. **a.** Male holotype. **b.** Rostrum of holotype of *P. affinis*. **c.** Rostrum of a cotype of *P. parvulus*.

back of the tip. On the ventral margin there is a series of 27 to 36 spines that are proximally reduced to indistinct serrations. A few setae arise from each of the spaces between the dorsal spines and each of the intervals between the ventral spines is provided with a single seta.

The third segment of the abdomen is bent at a sharp angle and its posterior half sharply carinated; the other segments are smoothly rounded dorsally. The postero-lateral angle of the pleuron of the fourth somite is provided with a small spine, and that of the fifth is narrowly acute. The sixth segment is two and two-thirds times as long as the preceding. The telson is slightly longer than the inner branch of the uropods and is armed with four to six, usually five, pairs of dorso-lateral spinules and three pairs of terminal spines.

The cornea of the eye is very large and semicircular so that it appears flattened in lateral view. There is no distinct ocellus.

The second and third joints of the antennular peduncle are subequal in length. The flagella are subequal and about one-third again as long as the rostrum.

The antennal scale is narrow and tapers distally to a rounded tip which slightly exceeds the outer spine.

The third maxillipeds attain the distal fifth of the antennal scale and are provided with well developed exopods. The first pair of legs are minutely chelate and very little shorter than the third maxillipeds. The second legs are unequal; the left reaches beyond the tip of the antennal scale and the carpus is composed of about 18 joints, whereas the right falls short of the tips of the first legs and there are but eight joints in the carpus. The three posterior legs are similar and exceed the tip of the antennal scale by the dactyls and part of the propodi. The carpi are about two-thirds, and the dactyls distinctly more than half, as long as the propodi.

The male holotype is 33 mm. long of which the carapace measures 5.2 mm., the abdomen 18.8 mm., and the rostrum 9 mm.

Local Distribution: A total of 66 specimens was taken from Santa Inez Bay (Station 147) and three miles east of Cape Falso (Station 151), between 60 and 65 fathoms, on muddy and rocky bottoms.

Sex and Size: The males have a carapace length of 4.2 to 6.8 mm. and the females, none of which is ovigerous, give comparative measurements of 3.1 to 6.7 mm.

Color in Life: Body transparent and colorless except for a variable number of red and yellow chromatophores on carapace and abdomen. Mouthparts yellowish.

Remarks: This species is very similar in general appearance to the only other species in the genus, *P. parvulus* A. Milne Edwards, from the Atlantic. There are, however, a few noticeable differences between the *Zaca* specimens and Milne Edwards' types which are deposited in the Museum of Comparative Zoology. *P. affinis* is apparently a larger species, since few of the cotypes are more than 25 mm. long. *P. parvulus* has only two to four, generally three, dorsal teeth at the base of the rostrum in front of the articulation, whereas *P. affinis* has from four to seven. There are normally 21 to 28 ventral rostral spines in *P. parvulus* as compared with 27 to 36 in *P. affinis,* and those in the latter species become mere indistinct serrations proximally, whereas in the Atlantic species even the first ventral spines are well marked. In *P. parvulus* there are usually six pairs of dorso-lateral spines on the telson, although rarely there may be only five; in *P. affinis,* five is the normal number and four or six are found but occasionally. Finally, the scaphognathite of the second maxilla is distinctly narrower in the genotype than in the Pacific species.

Material: *Station* 147: D-2 (37 ♂, 28 ♀). *Station* 151: D-1 (1 ♂). Cat. Nos. 36,1052 (holotype); 36,1053, 36,1054 (paratypes). Six male and seven

female paratypes are deposited in the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,495).

Heterocarpus vicarius Faxon.

Heterocarpus vicarius Faxon, W., *Bull. Mus. Comp. Zool.*, vol. 24, p. 203, 1893.

Heterocarpus vicarius Faxon, W., *Mem. Mus. Comp. Zool.*, vol. 18, p. 148, pl. 40, figs. 1-1b, pl. 41, figs. 2, 2a, 1895.

General Range: Previously known only from the Bay of Panama.

Local Distribution: A total of three specimens was taken 20 miles northeast of San Ildefonso Island (Station 148) and from Gorda Banks (Station 150), between 40 and 300 fathoms.

Sex and Size: The specimens are of the same small size, about 28 mm. long (carapace, 7.5 mm.)

Remarks: These specimens differ from the smallest of Faxon's types in the Museum of Comparative Zoology in having a more membranous integument, less pronounced lateral carinae on the carapace and a less upturned rostrum, but as the *Zaca* specimens are considerably smaller than any of the *Albatross* specimens these comparatively unimportant differences may well be accounted for by the age of the specimens.

This is apparently the first time that this species has been taken outside of the Gulf of Panama and the northernmost record for any member of the genus on the Pacific coast of America.

Material: *Station* 148: T-6 (1 young). *Station* 150 D-5 (2 young). Cat. Nos. 36,1055, 36,1056.

CRANGONIDAE.

Crangon bellimanus (Lockington).

Alpheus bellimanus Lockington, W.N., *Proc. Calif. Acad. Sci.*, vol. 7, p. 34, 1877.

Crangon bellimanus Schmitt, W.L., *Univ. Calif. Pub. Zool.*, vol. 23, p. 75, fig. 51, 1921.

General Range: Monterey to San Diego, California; Chile (Coutière).

Local Distribution: One male was taken from Arena Bank (Station 136: D-6) in 35 fathoms, on a sandy bottom. Cat. No. 36,1057.

Sex and Size: The single male is about 13.5 mm. long (carapace and rostrum, 4.9 mm.).

Remarks: The present specimen differs from Holmes' description (*Occas. Papers Calif. Acad. Sci.*, vol. 7, p. 184, pl. 2, fig. 41, 1900) only in having the antennal scale slightly longer than the antennular peduncle rather than equal to it.

This is the first record for the species from Lower California.

Crangon ventrosus (H. Milne Edwards).

Alpheus ventrosus Milne Edwards, H., *Hist. Nat. Crust.*, vol. 2, p. 352, 1837.

Alpheus ventrosus Gravely, F. H., *Bull. Madras Govt. Mus.*, N.S. vol. 1, no. 2, pt. 1, p. 78, pl. 1, figs. 2a-3b, 1930.

General Range: Entire Indo-Pacific region from the Gulf of Akaba, Red Sea, Indian Ocean to Tahiti, the Hawaiian Islands and the Gulf of California.

Local Distribution: Ten specimens (3 males, 4 females and 3 young) were taken off Arena Bank (Station 136 D-33) at a depth of 2½ fathoms in coral (*Pocillopora ligulata*). Cat. No. 36,1058.

Sex and Size: All four adult females are ovigerous and range in length from 27.8 to 32 mm. (carapace and rostrum, 8.9 to 10 mm.); the males are from 24 to 29 mm. long (carapace and rostrum, 8.2 to 9.1 mm.); and the immature specimens from 14 to 20 mm. (carapace and rostrum, 4.8 to 6.8 mm.).

Remarks: In one of the ovigerous females the telson is curiously deformed. It is split at the end, with two quite normal tips separated by an angle of about 90°. The posterior pair of dorsal spinules is placed almost in the midline, one of them being much the smaller and placed slightly anterior to the other.

This is the second record of the capture of this species in the Gulf of California.

Three specimens are deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,496).

Crangon arenensis, sp. nov.

(Text-figure 4).

Type: Male holotype, Cat. No. 36,1059, Department of Tropical Research, New York Zoological Society. From Station 136 D-33, off Arena Bank, 2½ fathoms, in coral (*Pocillopora ligulata*), May 2, 1936.

Diagnosis: Rostrum triangular, carinate and separated from orbital hoods by distinct sulci. Extra-corneal spines present. Second joint of antennular peduncle about twice as long as third; stylocerite not reaching second segment. Inferior spine of basicerite present. Larger chela slightly more than twice as long as high with slight dorsal and ventral emarginations but no lateral grooves or spines. Smaller chela little more than three times as long as high. First carpal article of second legs shorter than sum of three following. Three posterior legs with unarmed meri and simple, acute dactyls.

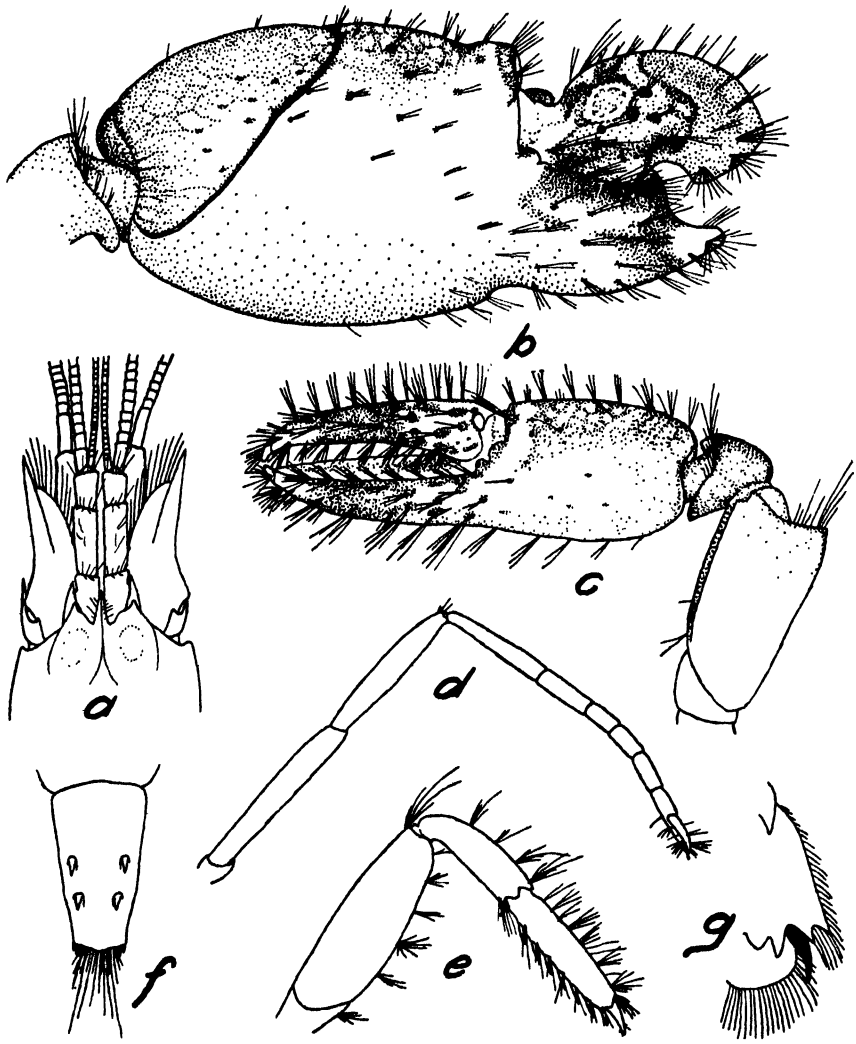
Description: The rostrum reaches the distal third of the visible portion of the first antennular segment. It is dorsally carinate, sparsely setose and separated from the orbital hoods by distinct sulci. The extra-corneal spines are prominent and reach as far as the distal third of the rostrum.

The second segment of the antennular peduncle is about one-third again as long as the visible portion of the first and about twice as long as the third. The stylocerite does not attain the end of the first segment. The inferior spine of the basicerite of the antennae is well developed and reaches the end of the first antennular segment. The carpocerite overreaches the antennular peduncle by about two-thirds of the length of the distal segment of the latter. The nearly straight outer spine of the antennal scale reaches the tip of the carpocerite and its distal third extends beyond the blade.

The third maxillipeds are hairy and extend beyond the carpocerite by about half of the terminal segment.

The merus of the larger cheliped is less than twice as long as broad at the distal end and unarmed. The chela is strongly compressed from side to side and but little less than half as high as long. Its outer surface is almost flat and smooth, the inner slightly more convex and hairy. Behind the articulation of the dactyl on the dorsal surface is an obliquely transverse groove which is most marked on the inner surface, but it terminates abruptly without extending far onto either lateral face. Ventrally there is a similar shallow emargination below the articulation of the dactyl, and above this ventral sulcus there is a very slight, ill-defined depression. Aside from

these emarginations and the well marked oblique groove on the proximal half of the palm, the chela is wholly free from sculpture. The thick, truncate dactyl is about three-fifths as long as the palm; it works in a very nearly vertical plane and extends somewhat beyond the fixed finger. In alcohol, the chela is mottled with blue and purple pigments. The smaller chela is just about three times as long as high and shows no trace of sculpture of any kind aside from a very slight depression on the ventral margin at the base of the fixed finger and the usual proximal oblique groove. The dactyl is about one-fourth again as long as the palm. The entire chela, particularly the fingers, is provided with numerous tufts of setae. The coloration in alcohol is similar to that of the larger hand.



Text-figure 4.

Crangon arenensis, sp. nov. **a.** Frontal region. **b.** Outer face of larger chela. **c.** Outer face of smaller chela. **d.** Right leg of second pair. **e.** Right leg of third pair. **f.** Telson. **g.** Outer branch of right uropod.

The second pair of legs is long, reaching the distal half of the larger chela. The first carpal joint is as long as the sum of the second and third and half of the fourth segments. The fifth is longer than the third or fourth which are subequal but shorter than the second.

The merus of the third leg is about one-third as broad as long and unarmed. The dactyls of the three posterior legs are simple, slender and acute.

The outer spine of the exopods of the uropods is black with a horn-colored tip.

The male holotype is 20 mm. long, of which the carapace and rostrum measure 7.5 mm. The larger chela is 10.8 mm. long and the smaller 7 mm.

Material: The male holotype is the only specimen in the collection.

Remarks: This species apparently resembles *C. gracilis alluaudi* (Coutière) from the Maldive Archipelago which, according to Coutière, differs from the typical *C. gracilis* (Heller) only in having simple rather than biunguiculate dactyls on the three posterior legs. De Man (Siboga-Expeditie, *Monogr.* 39a, 1911, p. 338) states that, in the type of *C. gracilis*, the second antennular article appears shorter than the visible part of the first and a little longer than the third, whereas in *C. arenensis* the second article is considerably longer than the visible part of the first and about twice as long as the third. In *C. gracilis* the stylocerite is said to reach the second third of the second antennular article, while in the present species it falls short of the end of the first segment. The merus of the third legs in *C. gracilis* is apparently more slender, being four times as long as wide as against about three in *C. arenensis*.

Crangon cylindricus (Kingsley).

Alpheus cylindricus Kingsley, J. S., *Bull. U. S. Geol. and Geogr. Surv.*, vol. 4, no. 1, p. 196, 1878.

Alpheus vanderbilti Boone, L., *Bull. Vanderbilt Mar. Mus.*, vol. 3, p. 163, pl. 58, text-fig. 5, 1930.

General Range: Off Key West, Florida, Barbados and Pearl Island, Bay of Panama.

Local Distribution: A total of 3 specimens was taken from Arena Bank (Station 136) in 35 and 45 fathoms, on muddy bottoms. One specimen was found inside a sponge.

Sex and Size: The male is 18.7 mm. long, the female without eggs from D-12 is 17.2 mm., and the ovigerous female from D-13 is 20.8 mm.

Remarks: These specimens have been compared with four specimens of "*C. vanderbilti* (Boone)" from the Bermudas and there is no apparent difference between the two. In all of the specimens from both the Atlantic and the Pacific the antennal scale reaches almost to the extremity of the antennular peduncle. Kingsley's statement regarding this ratio is ambiguous and might be construed to mean that the laminate portion, and not the terminal spine of the scaphocerite, reaches the end of the second joint, which is true of the specimens at hand. The dactyl of the larger chela may or may not have a subterminal rounded tooth on the lower margin in addition to the acute tooth which fits over the extremity of the propodus. Miss Boone's description of the dactyls of the last three pairs of legs is misleading, since she calls them "monodactyl" and also adds, "the dactyl is short, curved, acuminate," although her figure correctly depicts them as biunguiculate.

This, to my knowledge, is the first Pacific record of this species since that of the type from the Bay of Panama.

Material: *Station* 136: D-12 (1 ♀), D-13 (1 ♂, 1 ♀). Cat. Nos. 36,1060, 36,1061.

Crangon normanni (Kingsley).

Alpheus affinis Kingsley, J. S., *Bull. U. S. Geol. and Geogr. Surv.*, vol. 4, no. 1, p. 195, 1878. (Not *A. affinis* Guise, 1854).

Alpheus normanni Kingsley, J. S., *Proc. Acad. Nat. Sci. Phila.*, p. 93, 1878.

Alpheus packardii Kingsley, J. S., *Proc. Acad. Nat. Sci. Phila.*, p. 417, 1879.

Alpheus packardii Zimmer, C., *Zool. Jahrb.*, suppl. 11, p. 409, figs. A^2-G^2, 1913.

General Range: North Carolina and Bermuda to Florida and West Indies; Panama.

Local Distribution: A single male specimen (Cat. No. 36,1062) was taken from Santa Inez Bay (Station 142 D-1) in 30 fathoms, on a bottom composed of sand and crushed shell.

Sex and Size: This male measures 20 mm. in length (carapace, 7 mm.).

Remarks: A comparison of this specimen with specimens of "*C. packardii*" from the Bermudas fails to disclose a single character by which the Atlantic and Pacific forms can be distinguished. I have also compared the *Zaca* specimen with two cotypes of *C. normanni* in the Museum of Comparative Zoology and found that, as in those specimens, the third maxillipeds fall short of the extremity of the antennal scale. Although Kingsley did not mention the similarity between the two species, the only important differences between the two, as described by him, is in the length of the third maxillipeds. Since it is found that Kingsley's description of *C. normanni* is erroneous in this respect, the only important distinguishing character must be abandoned and the two species become synonymous.

To my knowledge, this is the first record of this species from Pacific waters since the types were collected at Panama.

Synalpheus charon (Heller).

Alpheus charon Heller, C., *Sitzungsber. Kais. Akad. Wiss. Wien*, vol. 44, p. 272, pl. 3, figs. 21 and 22, 1861.

Synalpheus charon de Man, J. G., Siboga-Exped., *Monogr.* 39a[1], p. 245, 1911.

General Range: Red Sea, Maldive and Laccadive Archipelagos and the Hawaiian Islands.

Local Distribution: A total of 11 specimens (Cat. No. 36,1063) was taken off Arena Bank (Station 136 D-33) in 2½ fathoms, from coral (*Pocillopora ligulata*).

Sex and Size: The collection includes four males, 12.3 to 15 mm. long, and seven ovigerous females, 14.2 to 20 mm. long.

Remarks: Some of these specimens closely resemble *S. helleri* de Man (*Zool. Jahrb. Abth. f. Syst.* 9, p. 743, pl. 35, fig. 63, 1897) in the form of the frontal spines and the length of the antennal scale. The posterior margin of the telson is more than one-third of the length of the telson in all of the specimens. It is very likely that study of additional specimens will show that *S. helleri* is synonymous with this species.

This is the first record for the species east of the Hawaiian Islands.

Two specimens, male and female, are deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts. (M. C. Z. Cat. No. 9,497).

Synalpheus sanlucasi Coutière.

Synalpheus sanlucasi Coutière, H., *Proc. U. S. Nat. Mus.*, vol. 36, p. 41, fig. 23, 1909.

General Range: Cape San Lucas, Lower California.

Local Distribution: Two males (Cat. No. 36,1064) were taken off Arena Bank (Station 136 D-33) in 2½ fathoms in coral (*Pocillopora ligulata*).

Sex and Size: The two males are each 9.1 mm. long.

Remarks: This species has been known previously only from the types taken at Cape San Lucas by John Xantus.

Synalpheus townsendi mexicanus Coutière.

Synalpheus townsendi mexicanus Coutière, H., *Proc. U. S. Nat. Mus.*, vol. 36, p. 34, fig. 17, 1909.

General Range: Off Ceralbo Island, Lower California, in 9½ fathoms.

Local Distribution: A total of 11 specimens was taken from Arena Bank in 2½ to 45 fathoms, on muddy bottoms and in coral (*Pocillopora ligulata*).

Sex and Size: The males are from 10.1 to 12.6 mm. long and the females, none of which are ovigerous, 11.1 to 12.7 mm. long.

Remarks: This is apparently the first record for the species since that of the type which was taken by the *Albatross* in 1888.

Material: *Station* 136: D-12 (4 ♂, 2 ♀), D-13 (2 ♂, 1 ♀), D-33 (2 ♂). Cat. Nos. 36,1065, 36,1066, 36,1067. Two specimens, male and female, are deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,498).

Synalpheus digueti Coutière.

Synalpheus digueti Coutière, H., *Proc. U. S. Nat. Mus.*, vol. 36, p. 48, fig. 28, 1909.

General Range: Lower California.

Local Distribution: A total of 22 specimens (12 males and 10 females) (Cat. No. 36,1068) was taken off Arena Bank (Station 136 D-33) in 2½ fathoms, in coral (*Pocillopora ligulata*).

Sex and Size: The males range from 7.8 to 15.7 mm. in length and the females, all of which are ovigerous, from 10.8 to 20 mm.

Remarks: This is the first record for the species since the description of the types.

Three males and two ovigerous females are deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,499).

Synalpheus herricki Coutière.

Synalpheus herricki Coutière, H., *Proc. U. S. Nat. Mus.*, vol. 36, p. 74, fig. 44, fig. 45 (subsp. *angustipes*), fig. 46 (subsp. *dimidiatus*), 1909.

General Range: Off west coast of Florida.

Local Distribution: A total of 12 specimens was taken from Arena Bank (Station 136) in 35 to 45 fathoms, on muddy bottoms.

Sex and Size: The males are 10.1 to 13.5 mm. long; the single female with eggs measures 18.2 mm. in length; the non-ovigerous females range from 13.7 to 18.7 mm. in length.

Remarks: Although there is little doubt that comparative measurements

Tribe *Graptocorixini* new

This tribe contains two genera, both from the western United States and Mexico. They may be separated by the following key:

A. Male abdomen sinistral, strigil absent. Female abdomen slightly asymmetrical. Face of female slightly concave........................*Neocorixa* Hungerford (See p. 150)

AA. Male abdomen dextral, strigil present. Female face not concave and abdomen normal ....*Graptocorixa* Hungerford (See p. 156)

Neocorixa Hungerford

1925. Hungerford, H. B. Bull. Brooklyn Ent. Soc. XX, No. 1, pp. 19-20.
1927. Poisson, R. Bull. de la Société Entomologique de France, 1927, pp. 74-75. (Assigned *A. vermiculata* (Put.) to this genus in error.)
1928. Hungerford, H. B. Annals Ent. Soc. Amer., XXI, p. 141.
1928. Jaczewski, T. Annales Musei Zoologici Polonici VII, pp. 59-61.
1935. Poisson, R. Archiv. de Zool. Exp. et Gén., LXXVII, p. 457.
1938. Hungerford, H. B. Bull. Brooklyn Ent. Soc., XXXIII, pp. 170-171.
1940. Hutchinson, G. E. Trans. Conn. Acad. Arts and Sciences, XXXIII, p. 404. (Places *Neocorixa* in the tribe Cymatiini Walton along with *Cymatia*.)

This genus has the general facies of *Graptocorixa*. The pala in both sexes is slender, falcate and ends in a stout claw. The face is short and broad, the frontal fovea marked and covered with a dense mat of hair in both sexes. The lateral lobe of the prothorax has the anterior distal angle produced and turned in. Mesosternum medianly bidentately produced. Hind femur pilose only at the base and along the caudal margin, its ventral shining surface with forty or more small peg-like spines, irregularly spaced. The asymmetry of the male sinistral. True strigil absent. The female abdomen also definitely asymmetrical due to a depression on the right side of the fifth ventral and a tuft of hair on the sixth behind it.

Genotype: *Neocorixa snowi* Hungerford.

Distribution: Southwestern United States and Mexico.

Neocorixa snowi Hungerford

(Plate XXIV, figs. 1, 2, 5, and 7; wash drawing No. 37, Plate VI)

1925. *Neocorixa snowi* Hungerford, H. B. Bull. Brooklyn Ent. Soc., XX, pp. 19-20, Pl. II, fig. 8. (New genus, new sp. from Arizona.)
1928. *Neocorixa snowi*, Hungerford, H. B. Ent. News XXXIX, p. 156. (Record from New Mexico.)
1928. *Neocorixa snowi*, Hungerford, H. B., Annals Ent. Soc. Amer., XXI, p. 141, Pl. VIII, fig. 13.
1935. *Neocorixa snowi*, Poisson, R. Archiv. de Zool. Exp. et Gén., LXXVII, p. 457.
1938. *Neocorixa snowi*, Hungerford, H. B. Pan-Pacific Ent. XIV, p. 76. (Record from Mexico.)
1938. *Neocorixa snowi*, Hungerford, H. B. Bull. Brooklyn Ent. Soc., XXXIII, pp. 170-171, Pl. VII, figs. 1, 2, 5, 7.

Size: Length 6.9 mm. to 8.2 mm. Width across head 2.3 mm. to 2.6 mm.

Color: General color usually dark, both dorsum and venter. Head and legs ivory to yellow, the second segment of hind tarsus brown. Pale patches on the sides of each thoracic segment, the mesothoracic epimeron usually suffused with black. Pronotum usually crossed by fourteen or more slender, more or less broken and anastomosing black bands which are about as wide as the intermediate pale bands. Except at the base of the clavus, the pale finely zigzag lines are narrower than the dark ones and the sculpturing of the hemeltyra is such that they appear as elevated across ridges; the slender pale lines of the membrane are more or less broken, but nevertheless give a crossbar effect. In many specimens the pattern of both clavus and corium is obscured by dark brown; nodal furrow covered by a large sooty blotch.

Structural characteristics: The so-called beak reduced. Frontal depression of male oval, not reaching the eyes; this area in both sexes densely clothed with fine white hairs. The relative length of the antennal segments 1 : 2 : 3 : 4 :: 30 : 20 : 42 : 15. The pronotum and hemelytra somewhat roughened, the latter more or less rugulose, a few fine hairs on corium; the pruinose area of embolar groove posterior to nodal furrow : cubital ridge as 10 : 21 and a little longer than the pruinose area of the claval fold. Mesoepimeron slender with the osteole of the scent gland near its tip. The metaxyphus nearly as long as the inner margin of the hind coxa. Lower margin of the basal half of front femur provided with a few strong spines; the tibia with several stout spines, the pala long, slender, tapering to a single stout claw in both sexes; the male pala provided with about thirty-two pegs arranged in a row just above the palm. The middle leg—femur : tibia : tarsus : claws :: 100 : 40 : 37 : 23. The hind leg—femur : tibia: tarsus 1 : tarsus 2 :: 100 : 97 : 125 : 45. The asymmetry of the male sinistral, a curious patch of short hook-like projections on the left side of the sixth dorsal abdominal tergite. The genital capsule of male as shown on Plate XXIV. The last ventral abdominal segment of female not rectangularly produced, and the notch on the inner ventral margin of the anal lobes deep. (See Plate XXIV.)

Comparative notes: This species has the general facies of some of the *Graptocorixa* species and the palae of the front legs are similar but it differs from any of them in having the male abdomen sinistral with a patch of short hooks replacing a strigil and the female abdomen also showing asymmetry.

Location of types: Described from 4 males and 4 females bearing

Of the larger chela, the merus is about two-thirds as wide as long and armed with an acute spine at the distal end of the dorsal margin. The carpus is small, almost hemispherical and unarmed. The hand is strongly compressed from side to side and twisted in such a way that, when the base of the hand is vertical, the fingers work in a plane that is practically horizontal. The chela is little more than twice as long as high and smooth and bare on the outer surface. There is a distinct notch in the ventral margin at the base of the fixed finger and both margins are coarsely rugose toward the inner surface with tufts of setae arising from the rugae. So strongly compressed is the hand that the inner surface is longitudinally concave due to the pronounced twist. The dactyl is low and curved; it extends beyond the fixed finger and fits into a notch on the inner side of the latter. The hand of the smaller chela is two and one-third times as long as high and a little shorter than the larger chela. It also is twisted and similarly rugose and setose on the inner surface of the margins. The dactyl is almost as long as the palm.

The second pair of legs reaches slightly beyond the third maxillipeds. The first joint of the five-jointed carpus is about one and one-half times as long as the second which is equal to the sum of the third and fourth. The fifth is subequal to the second.

There is a tooth at the distal end of the lower margin of the meri of the third and fourth legs but none on that of the fifth. The dactyls of the last three legs are biunguiculate, the two hooks being of approximately equal width at the base and directed along the general axis of the dactyl.

The telson is about one and three-fourths times as long as its basal width, convex at the distal end with the outer corners acute. There is a single spine at the outer angle of the exopod of the uropods and the endopod is armed with a row of six distinct spines at the corresponding angle.

The eggs are about 0.3 mm. in diameter.

The holotype is 15 mm. long, of which the carapace and rostrum amount to 5 mm.

Material: The female holotype is the only example in the collection.

Remarks: This unique species is apparently most closely related to the species of the genus *Synalpheus* as shown by the lack of epipods on the thoracic legs, the well-developed orbital hoods, the biunguiculate dactyls of the third, fourth and fifth pairs of legs, the small branch on the outer flagellum of the antennules and the reduced blade of the antennal scale. It is readily distinguished from the members of that genus, however, by the form of the larger chela of the first pair of legs and the opercular third maxillipeds. The latter is a character met with in genera of other families as in *Gnathophyllum* and *Anchistus*.

HIPPOLYTIDAE.

Hippolyte californiensis Holmes.

Hippolyte californiensis Holmes, S. J., *Proc. Calif. Acad. Sci.*, ser. 2, vol. 4, p. 576, pl. 20, figs. 21-26, 1895.

Hippolyte californiensis Schmitt, W. L., *Univ. Calif. Pub. Zool.*, vol. 23, p. 48, fig. 26, 1921.

General Range: From Sitka, Alaska, to San Diego, California, to a depth of 10 fathoms.

Local Distribution: A total of 96 specimens was taken from kelp on the west coast of Lower California, from stomachs of the American Eared Grebe at Santa Inez Bay and dredged in Santa Inez Bay (Station 144) in 3 fathoms, on a sandy bottom with abundant weed.

Sex and Size: The specimens taken from the Grebes are in such condi-

tion that the determination of sex is practically impossible. Of the 94 specimens and fragments thus taken, however, 29 carried eggs. The single intact male is 18.5 mm. long, of which the carapace measures 3.7 mm. All intact females are ovigerous. The largest, that dredged in Santa Inez Bay, is 21.8 mm. long with a carapace of 4.2 mm. The other ovigerous females give carapace lengths ranging from 3 to 3.9 mm.

Remarks: Although this is the first record for the species from Lower California, the specimens agree with Holmes' description and figures even more closely than many of the specimens taken in California. In only one specimen, the male, is the extremity of the rostrum trifid. In all other specimens in which the rostrum is intact (31 specimens) the most anterior of the rostral spines is far back of the tip, although the last ventral spine is very near the apex. The rostral formula in these specimens is $\frac{2-4}{3-5}$, usually $\frac{3.}{5.}$

Material: *Off Cape San Lazaro (March 28), in kelp*: (1 ♂). *Santa Inez Bay (April 9), in stomach of female American Eared Grebe*: (17 specimens). *Santa Inez Bay (April 11), in stomach of male American Eared Grebe*: (75 specimens). *Station* 144: D-7 (1 ♀). Cat. Nos. 36,1072 to 36,1075 inclusive.

Hippolyte mexicana, sp. nov.

(Text-figure 6).

Type: Holotype male, Cat. No. 36,1076, Department of Tropical Research, New York Zoological Society. From Station 144, D-1, Santa Inez Bay, Lat. 26° 50′ 45″ N., Long. 111° 54′ 20″ W., 1 fathom, April 15, 1936, on a sandy bottom.

Diagnosis: Branchiostegal spine present. Rostrum armed both above and below. First segment of antennular peduncle armed distally with three spines. Last three pairs of thoracic legs markedly prehensile, the propodus being considerably dilated and the dactyl armed with seven terminal spines in addition to row on lower or inner margin.

Description: The smoothly rounded carapace is a little more than one-third as long as the abdomen. The supra-orbital spine is strong as is also the antennal spine which is separated by a notch from the acute lower angle of the orbit. The branchiostegal spine is set well back from the margin of the carapace.

The rostrum is about seven-tenths as long as the carapace, reaching the distal half of the second segment of the antennular peduncle. It is armed above with from two to four, usually three, teeth and below with from one to three, usually two, placed near the tip.

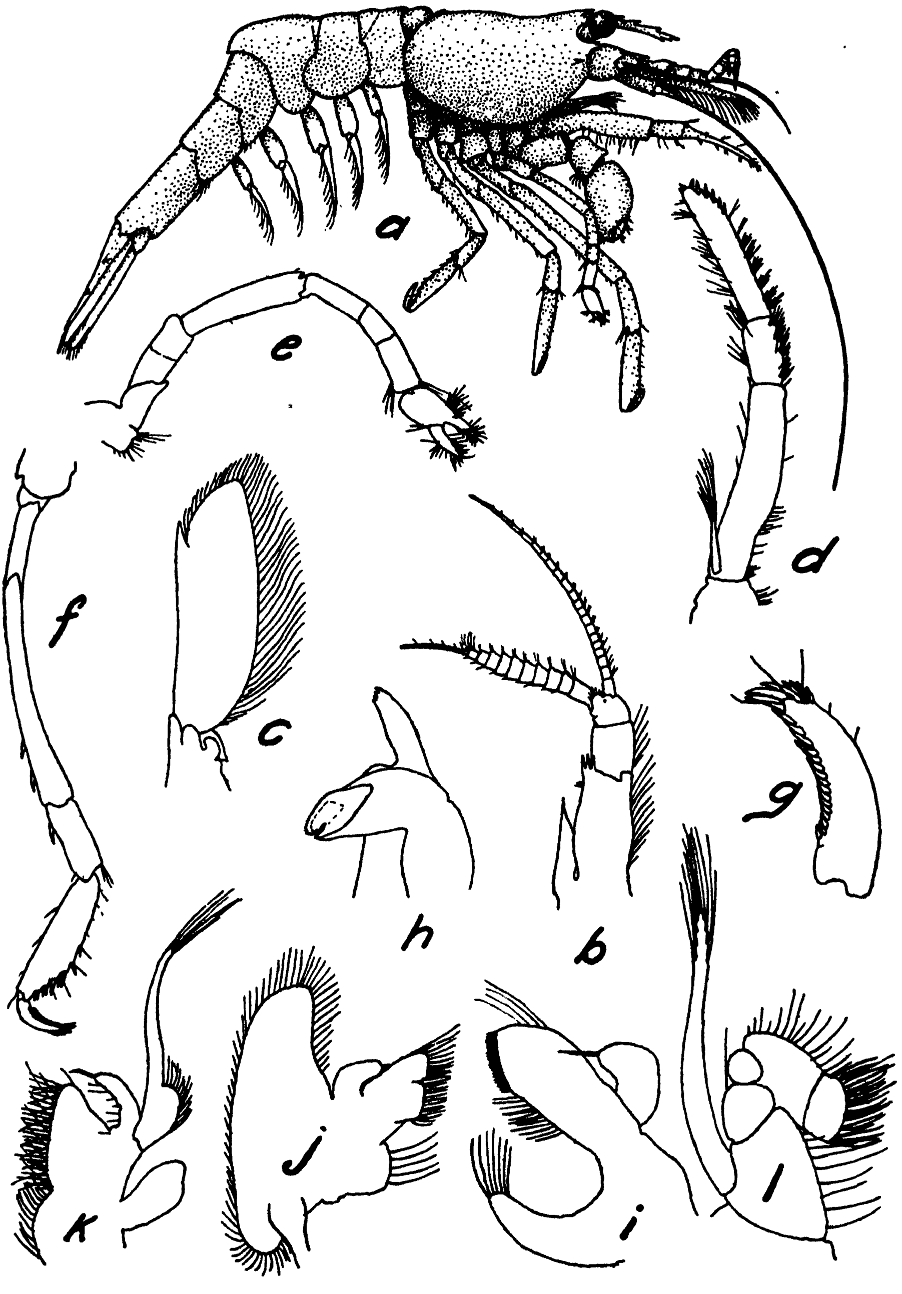
None of the abdominal segments is carinate although the third is compressed into a blunt cap extending over the base of the fourth. The sixth is about one and three-fourths times as long as the fifth. The telson, which is somewhat longer than the sixth somite, bears two pairs of dorso-lateral and three pairs of terminal spines, the median pair of the latter being the longest and the outer pair much the shortest.

The eyes are set on comparatively long stalks so that, when turned forward, they extend to the tip of the stylocerite.

The latter is well-developed and sharp but falls considerably short of the second antennular segment. On the outer part of the distal margin of the first segment are three strong spines. The inner antennular flagellum is made up of about 22 segments while the thick, twisted outer one is composed of about 16 segments, 10 of which make up the thickened proximal portion.

Although well-marked and strong, the outer spine of the antennal scale is greatly exceeded by the blade. The antennal flagellum is more than half as long as the body of the animal.

The external maxilliped extends beyond the tip of the antennal scale



Text-figure 6.

Hippolyte mexicana, sp. nov. **a.** Male holotype. **b.** Left antennule from above. **c.** Antennal scale. **d.** Third maxilliped. **e.** Second leg. **f.** Third leg. **g.** Dactyl of third leg. **h.** Mandible. **i.** First maxilla. **j.** Second maxilla. **k.** First maxilliped. **l.** Second maxilliped.

and bears a small exopod. The terminal segment is dorsally compressed and provided with a row of stout spines at the apex. The first legs are short and robust. In the second legs, the merus is about as long as the first two and half of the third joints of the carpus; the first carpal segment is not quite twice as long as the second and noticeably shorter than the third; the chela is about as long as the sum of the second and third carpal joints. The last three legs are similar in form with the dactyl folded against the inner margin of the dilated propodus. Much the longest of the three, the third leg extends forward beyond the third maxillipeds; the merus is longer than the carpus and propodus taken together; the propodus is expanded so that its greatest width is contained about three and one-half times in its length, and the inner edge is provided with a series of paired spines between which the dactyl rests when flexed; and the dactyl is provided with a row of about 16 overlapping spines on the inner margin and two large subequal spines at the tip which are followed by a row of five spines on the outer part of the apex which become progressively smaller proximally.

The male holotype is 18.5 mm. long, of which the carapace measures 3.8 mm., the abdomen 12.2 mm., and the rostrum 2.6 mm.

Local Distribution: A total of 41 specimens was taken from specimens of the American Eared Grebe at Santa Inez Bay and dredged in the same body of water (Station 144) in one fathom, on a sandy bottom with abundant weed.

Sex and Size: It is worthy of note that all of the specimens in which the determination of sex is possible are males. All of the specimens taken from Grebes are slightly smaller than the type, having a carapace length of 2.7 to 3.5 mm.

Remarks: This species is apparently the Pacific representative of the group made up of *H. exilirostris* Dana from Brazil and *H. curaçaoensis* Schmitt from Curaçao, both of which have the last three thoracic legs well adapted for prehensile purposes. *H. mexicana* differs from the first by having ventral teeth on the rostrum, the fingers of the second legs differently shaped and seven rather than three spines at the tips of the dactyls of the three posterior legs. The similarity between the present species and *H. curaçaoensis* is very striking. However, the dactyls of the three posterior legs in the latter terminate in three subequal spines, whereas in *H. mexicana* there are but two subequal spines followed by five smaller ones. The outer flagellum of the antennules in the present species is composed of 16 segments, 10 of which make up the thickened portion, while in *H. curaçaoensis* there are 8 segments, only the last of which is slender. In the Pacific species the basal joint of the antennular peduncle is armed with three spines in contrast to the single one in the Atlantic form. Finally, the outer spine of the antennal scale is apparently stouter and the legs longer and more slender, particularly the carpus of the second leg and the merus of the third, in *H. mexicana*.

Material: *Station* 144: D-1 (1 ♂). *Santa Inez Bay* (*April* 9), *in stomach of female American Eared Grebe*: (9 ♂, 1 mutilated specimen). *Santa Inez Bay* (*April* 11), *in stomach of male American Eared Grebe*: (16 ♂, 14 mutilated specimens). Cat. Nos. 36,1076 (holotype); 36,1077, 36,1078 (paratypes). Two of the male paratypes are in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,501).

Latreutes, sp.

(Text-figure 7).

Diagnosis: Carapace armed with four strong dorsal spines behind orbit. Rostrum deep, armed with eight dorsal, one ventral and four terminal spines. Blade of antennal scale broad and extending beyond outer spine. Anterolateral angle of carapace armed with row of about ten spines.

Description: The carapace bears a row of four spines in the dorsal midline, the two in the middle being the largest. The antennal spine is strong and below it at the antero-lateral angle is a row of about ten spines, the four or five dorsal ones being set back from the edge of the carapace.

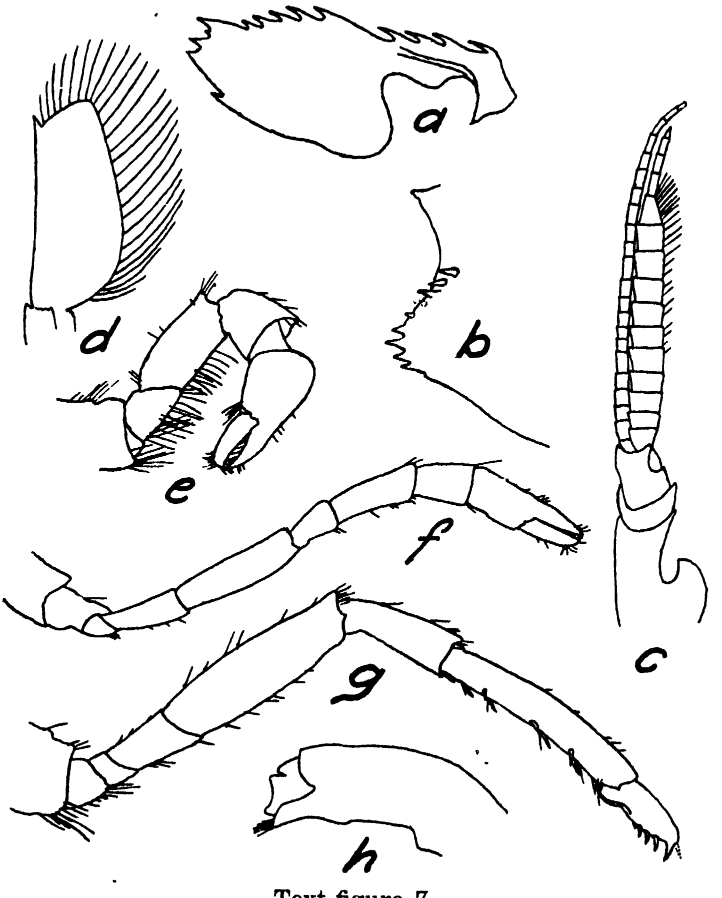
The rostrum bears eight dorsal teeth and there is a single tooth near the distal end of the deep lower margin. There are four unequal spines along the truncate apex. Supporting the rostrum at the base is a strong lateral carina.

The antennular peduncle has a broad, obtuse stylocerite. The outer antennular flagellum consists of an eleven-jointed thickened portion terminating in a slender, four-jointed filament; the outer flagellum is slightly longer than the inner and is made up of about 25 segments.

The blade of the broad antennal scale considerably surpasses the outer spine.

The flattened terminal joint of the third maxilliped is armed with a row of stout spines at the tip. The exopod is short.

The first segment of the carpus of the second leg is about two-thirds as long as the second and slightly shorter than the third. The chela is a little shorter than the sum of the first two carpal joints. The propodus of the



Text-figure 7.
Latreutes, sp. **a.** Rostrum. **b.** Antero-lateral margin of carapace. **c.** Antennule. **d.** Antennal scale. **e.** First leg. **f.** Second leg. **g.** Third leg. **h.** Mandible.

third leg is armed with five pairs of spines on the posterior margin and the dactyl is armed with six spines and has a fairly well developed "heel."

The telson bears two pairs of dorso-lateral and three pairs of terminal spines.

Local Distribution: One very much mutilated ovigerous female without a rostrum and the rostrum and anterior part of the carapace of a second specimen were taken from an American Eared Grebe at Santa Inez on April 9. (Cat. No. 36,1079).

Remarks: This species seems to be most closely allied to *L. mucronatus* (Stimpson) and *L. porcinus* Kemp in its general appearance, but it differs from them in having the blade of the antennal scale very broad and longer than the outer spine.

It is with great hesitancy that any mention is made of these specimens, due to their extremely poor condition, but since this is apparently the first time any species of this genus has been taken on the west coast of North America, it may be worthwhile to acquaint collectors with the existence of such a species and so encourage a search for more perfect specimens.

PROCESSIDAE.

Processa canaliculata Leach.

Processa canaliculata Leach, W. R., *Mal. Podophth. Brit.*, pl. 41 and corresponding text, 1815.

Processa canaliculata Lebour, M. V., *Proc. Zool. Soc. London*, pt. 3, p. 612, pls. 1 to 4, 1936.

General Range: Uncertain. Coasts of England; probably also West Indies and west coast of America from San Diego to Panama Bay to a depth of 182 fathoms; possibly widely distributed in offshore waters of both Atlantic and Pacific.

Local Distribution: A total of three specimens was taken from Magdalena Bay in half a fathom, under stones, and at Arena Bank (Station 136) in 45 and 55 fathoms, on muddy bottoms.

Sex and Size: The small female from Magdalena Bay is 16 mm. long (carapace, 4.7 mm.); the female from Station 136 is 26 mm. long (carapace, 7.2 mm.); and the male has a length of 24 mm. (carapace, 6.7 mm.).

Remarks: There is little doubt that the two specimens from Station 136 belong to this species as they agree in practically every particular with Miss Lebour's description. The small specimen from Magdalena Bay, however, differs in having no spines on the meri of the third legs. As it agrees with the other specimens in all other particulars, it seems best to await further specimens from the shallow waters of this coast before assuming that this distinction warrants specific designation. There is a distinct antennal spine in all three specimens.

Material: *Shore of Magdalena Bay*: (1 ♀). *Station* 136: D-4 (1 ♀), D-9 (1 ♂). Cat. Nos. 36,1080, 36,1081.

PALAEMONIDAE.

Palaemon ritteri Holmes.

Palaemon ritteri Holmes, S.J., *Proc. Calif. Acad. Sci.*, ser. 2, vol. 4, p. 579, pl. 21, figs. 29-35, 1895.

Palaemon ritteri Schmitt, W.L., *Univ. Calif. Pub. Zool.*, vol. 23, p. 35, fig. 21, 1921.

General Range: San Diego, California, to Gulf of California; Bay of St. Elena, Ecuador. Shallow water.

Local Distribution: A total of seven specimens was taken at Magdalena Bay and Santa Inez, at depths of 1 to 3 feet, under stones.

Sex and Size: The two males have a length of about 27.5 mm. (carapace, 4.9 mm.), the non-ovigerous females range from 28 to 30.5 mm. in length (carapace, 5 to 5.9 mm.) and the single ovigerous female, from Santa Inez, is 33 mm. long (carapace, 6.8 mm.).

Material: *Magdalena Bay*: (2 ♂, 4 ♀). *Santa Inez Bay*: (1 ♀). Cat. Nos. 36,1082, 36,1083. A male and a female are deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,502).

Periclimenes (Periclimenes) infraspinis (Rathbun).

Urocaris infraspinis Rathbun, M.J., *Proc. U.S. Nat. Mus.*, vol. 24, p. 903, 1902.

Urocaris infraspinis Schmitt, W.L., *Univ. Calif. Pub. Zool.*, vol. 23, p. 37, fig. 22, 1921.

General Range: San Diego Bay, California, and Gulf of California. Shallow water.

Local Distribution: A total of 14 specimens was taken from Santa Inez Bay (Station 144) both with the dredge in three fathoms, on a sandy bottom with abundant weed, and taken from the stomach of a male American Eared Grebe.

Sex and Size: Seven of the females from the Grebe are ovigerous. The carapaces of these specimens vary from 3.1 to 3.7 mm. The non-ovigerous females have a carapace length of 3.2 to 4 mm. The carapace length of the males is from 2.3 to 3.1 mm.

Color in Life: Semi-translucent, pale brown.

Material: *Station* 144: D-7 (1 ♀). *Santa Inez Bay, in stomach of male American Eared Grebe*: (4 ♂, 9 ♀). Cat. Nos. 36,1084, 36,1085. A male and a female are deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,503).

Periclimenes (Ancylocaris) holmesi Nobili.

Anchista tenuipes Holmes, S.J., *Occas. Pap. Calif. Acad. Sci.*, vol. 7, p. 216, 1900. (Not *P. tenuipes* Borradaile).

Periclimenes holmesi Nobili, G., *Ann. Mus. Univ. Napoli* (N.S.) vol. 2, no. 21, p. 5, 1907.

Periclimenes (Ancylocaris) holmesi Kemp, S., *Rec. Ind. Mus.*, vol. 24, p. 218, 1922.

General Range: From Santa Catalina Island, California, to Gulf of California. Shallow water.

Local Distribution: A total of eight specimens was taken from Magdalena Bay, San Lucas Bay and Santa Inez Bay in one-half to 20 fathoms, on sandy bottoms with weed.

Sex and Size: With the exception of the two specimens from Station 141 all of the females are ovigerous. They are from 14.5 to 19 mm. long (carapace, 2.9 to 4 mm.). The non-ovigerous females have a carapace length of 3.6 to 4.3 mm. The single male is 17 mm. long with a carapace length of 3.2 mm.

Color in Life: Semi-translucent, pale brown.

Remarks: The following characters readily distinguish this species from *P. (A.) elegans* (Paulson) as described and figured by Kemp. The terminal spine of the basal antennular joint is short, falling far short of the distal

half of the second joint. The latter is much more slender than in *P.* (*A.*) *elegans.* The antennal scale is only about three and two-thirds times as long as wide as compared with four and one-half to five and one-half times the width in the Indian species. The first legs extend beyond the antennal scale by the length of the chela. The spine at the end of the merus of the second legs is short and blunt, only slightly more acute than a right angle. Finally, the fifth legs extend to the tip of the antennal scale in all specimens and they may extend beyond it by as much as the dactyl and half of the propodus. In the specimens at hand there are seven or eight dorsal and three ventral teeth on the rostrum.

Material: *Shore of Magdalena Bay*: (1 ♀). *Station* 135: D-9, D-10 (1 ♂, 1 ♀), D-18 to D-25 (1 ♀). *Station* 141: D-2, D-3 (2 ♀). *Station* 144: D-4, D-6 (2 ♀). Cat. Nos. 36,1086 to 36,1089 inclusive. One specimen is deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,504).

Periclimenes (Ancylocaris) lucasi, sp. nov.

(Text-figure 8).

Type: Holotype female, Cat. No. 36,1090, Department of Tropical Research, New York Zoological Society. From Station 135 D-18 to D-25, San Lucas Bay, Lat. 22° 53′ N., Long. 109° 54′ W., 3 to 9 fathoms, May 7, 1936.

Diagnosis: Hepatic but no antennal spine. Rostrum falls short of third antennular segment, ascendent, deep, ventrally straight, dorsally convex, armed with 8 to 11 dorsal and 1 to 3 ventral teeth. Sixth abdominal somite fully twice as long as fifth. Distal spine of antennal scale does not attain end of blade. Merus of second leg falls short of tip of antennal scale and is unarmed at distal end of lower margin. Carpus of larger leg of second pair about half as long as chela, that of smaller almost as long as chela.

Description: The carapace is very short, little longer than the sum of the first two abdominal somites. The antennal spine is well-marked, but small, not reaching the narrowly rounded lower angle of the orbit. The hepatic is somewhat larger and more prominent. There are no supraorbital spines.

The rostrum is strongly ascendent and, although it is about as long as the carapace, it does not attain the level of the third segment of the antennular peduncle. It is about one-fourth as deep as long. The dorsal margin is convex and the ventral straight or even slightly concave. There are from 8 to 11 dorsal teeth of which one or two are behind the orbit and the ventral edge is provided with from one to three inconspicuous denticles near the tip.

All of the abdominal somites are smoothly rounded on the dorsal surface although the third is compressed into a cap-like hump overlapping the base of the fourth segment. The sixth segment is a little more than twice as long as the preceding and the telson is about as long as the sixth somite. The telson bears two pairs of minute dorso-lateral spines, the anterior pair situated about two-fifths of the telson length from the end and the posterior pair midway between the first pair and the tip. There are three pairs of terminal spines, the outer pair minute and the median pair somewhat smaller than the large intermediate pair.

The eyes are slightly wider than the long stalks.

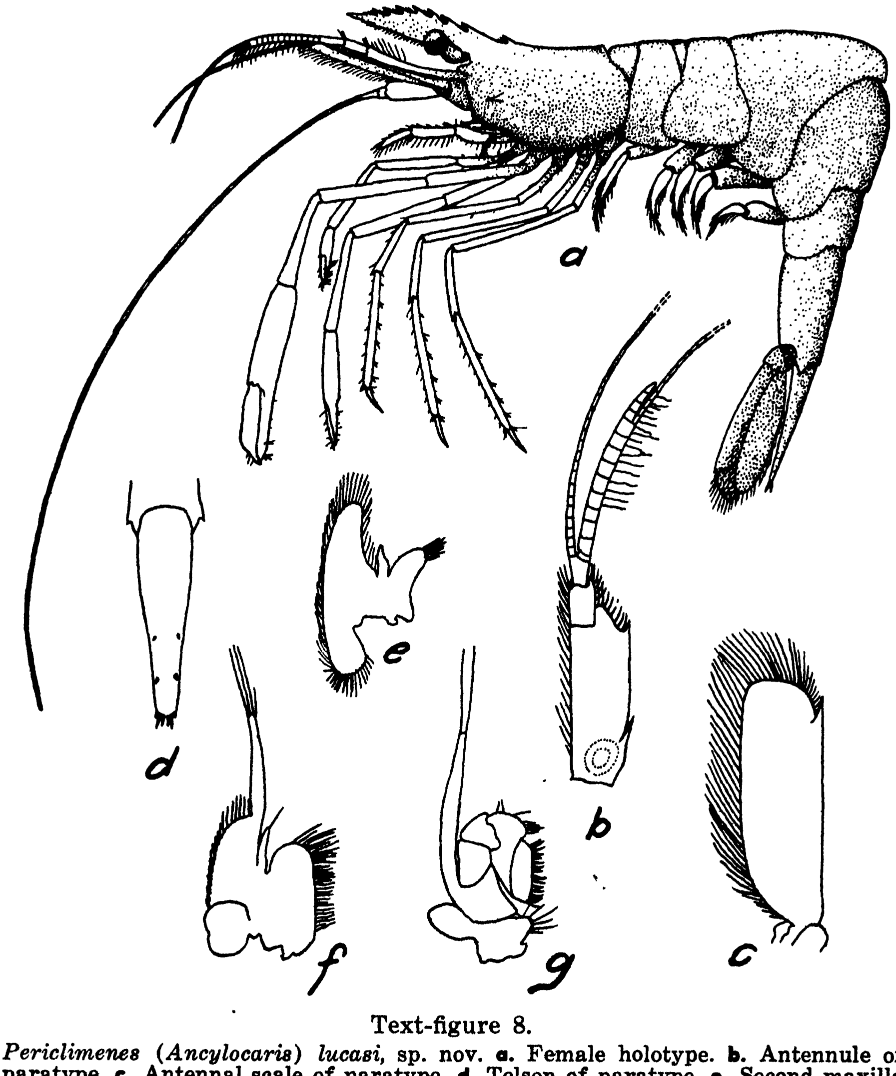
The second segment of the antennular peduncle is considerably longer than the terminal one. The basal segment is produced into a terminal lobe which extends halfway along the outer margin of the second segment, but the outer margin of this lobe recedes rapidly in a sinuous curve to the outer terminal spine which is consequently set well behind the end of the lobe. The outer flagellum forks at the tenth segment and the inner branch is made up of four segments.

The margins of the antennal scale are subparallel for the most part and

the broadly truncate end of the lamellate portion extends well beyond the outer spine.

In comparison with the thoracic legs, the external maxillipeds are quite feeble; they extend about to the tips of the eyes when the latter are turned forward. All three maxillipeds are provided with exopods.

The first pair of legs reaches beyond the antennal scale by about half the length of the chelae. The second legs are subequal. The larger extends beyond the antennal scale by the length of the chela and two-thirds of the carpus. The latter is more than twice as long as the chela and the fingers are about three-fourths as long as the palm. The dactyl is laterally expanded in its distal half. The smaller leg of this pair overreaches the antennal scale by the length of the chela and half of the carpus, the carpus is but little shorter than



Text-figure 8.

Periclimenes (Ancylocaris) lucasi, sp. nov. a. Female holotype. b. Antennule of paratype. c. Antennal scale of paratype. d. Telson of paratype. e. Second maxilla of paratype. f. First maxilliped of paratype. g. Second maxilliped of paratype.

the chela and the dactyl is not expanded. Each of the propodi of the third and fourth legs has six slender spinules on the lower margin, and that of the fifth leg has five. The dactyls of these legs are almost one-fourth as long as the propodi. The fourth leg extends beyond the antennal scale by the length of the dactyl and one-half of the propodus.

The holotype is about 24 mm. long, of which the carapace measures 3.8 mm. and the rostrum 3.8 mm.

Local Distribution: A total of five specimens was taken from San Lucas Bay (Station 135) and Arena Bank (Station 136) between 3 and 45 fathoms, on sandy and muddy bottoms.

Sex and Size: The single male is about 19 mm. long (carapace, 2.9 mm.) and the females, none of which are ovigerous, are from 22.5 to 24.5 mm. long (carapace, 3.3 to 4.1 mm.).

Color in Life: A specimen from San Lucas was plain, semi-translucent white.

Remarks: The male differs from the females in having the second legs subequal and similar. Whether this may be due to the small size of the specimen or no cannot be determined at present. Kemp (*Rec. Ind. Mus.*, vol. 24, p. 181, 1922) has shown that in at least one related species of the genus, *P.* (*A.*) *diversipes* Kemp, four distinct types of second legs may be encountered.

As Kemp has stated, it is impossible at present to decide which are the more important characters in the species of this genus and the species to which *P.* (*A.*) *lucasi* is most closely related can only be conjectured. According to Kemp's extremely helpful key, this species would fall near *P.* (*A.*) *diversipes*, but it is distinguished at once from that species by the sharply ascendent rostrum, the form of the antennules, and antennal scale and the longer thoracic legs.

Material: *Station* 135: D-11 and D-12 (1 ♂, 1 ♀), D-18 to D-25 (2 ♀). *Station* 136: D-1 (1 ♀). Cat. Nos. 36,1090 (holotype); 36,1091, 36,1092 (paratypes). A female paratype is deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,505).

Harpilius depressus Stimpson.

Harpilius depressus Stimpson, W., *Proc. Acad. Nat. Sci., Phila.*, p. 38 (1860) 1861.

Harpilius depressus Kemp, S., *Rec. Ind. Mus.*, vol. 24, p. 231, figs. 69 to 71, 1922.

General Range: Red Sea, Seychelles, Minikoi, Maldives, Chagos Archipelago, Loyalty Islands, Rotuma and the Hawaiian Islands, in coral.

Local Distribution: One specimen (Cat. No. 36,1093) in poor condition was taken off Arena Bank (Station 136 D-33) at a depth of 2½ fathoms, in coral (*Pocillopora ligulata*) on May 2, 1936. This specimen is about 15 mm. long (carapace, 3.2 mm.).

Remarks: This specimen approaches Kemp's variety *gracilis* in having the anterior pair of telson spines placed much behind the middle of the telson and the posterior pair about equidistant between the first pair and the apex. Likewise, the second leg is more slender than that described as the typical form by Kemp, the merus being three and one-half times as long as wide and the palm about four times as long as wide. The rostrum has seven dorsal and three ventral teeth.

This is apparently the first time this species has been taken east of the Hawaiian Islands.

Pontonia margarita Smith.

Pontonia margarita Smith, S.J., in Verill, A.E., *Am. Naturalist*, vol. 3, p. 245, 1869.

Pontonia margarita Kemp, S., *Rec. Ind. Mus.*, vol. 24, p. 287, 1922.

General Range: Gulf of Panama and Gulf of California.

Local Distribution: A total of nine specimens was taken at San Domingo Point, in the Inez area, and on Pulmo Reef from pearl oysters, collected at depths of from one to two fathoms.

Sex and Size: The males have a total length of from 18.5 to 21 mm. (carapace, 5.9 to 6.7 mm.); two ovigerous females from San Domingo Point have a total length of about 26 mm. (carapace, 8.2 and 8.9 mm.); and the non-ovigerous females are from 20.5 to 24 mm. long (carapace, 6.2 to 7.2 mm.).

Remarks: Inasmuch as the genus *Conchodytes* Peters differs from *Pontonia* only in having a basal protuberance on the dactyls of the last three thoracic legs, a distinction which is certainly of no greater importance than that between the simple and biunguiculate dactyls of species which have been commonly referred to *Pontonia*, it seems to me that little is to be gained by retaining *Conchodytes*. The basal protuberance of the dactyls in the latter genus varies from a large, toothed structure in such species as *C. biunguiculatus* (Paulson) and *C. nipponensis* (de Haan) to an unarmed, rounded lobe in *C. tridacnae* Peters and *C. meleagrinae* Peters and finally to a lobe so inconspicuous in *C. margarita* that Kemp was led to place that species in the genus *Pontonia*. It is therefore my opinion that all of the species constitute a single natural group closely allied to, but probably generically distinct from, *Anchistus* Borradaile and separated from the remaining genera of the Pontoniinae by several important characters.

Material: *San Domingo Point*: (3 ♂, 4 ♀). *Pulmo Reef*: (1 ♂, 1 ♀). Cat. Nos. 36,1094, 36,1095. A male and a female are deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,506).

CRAGONIDAE.

Crago zacae, sp. nov.

(Text-figure 9).

Type: Holotype female, Cat. No. 36,1096, Department of Tropical Research, New York Zoological Society. From Station 125, D-1, east of Cedros Island, Lat. 28° 13′ N., Long. 115° 07′ W., 44 fathoms, on a muddy bottom, March 27, 1936.

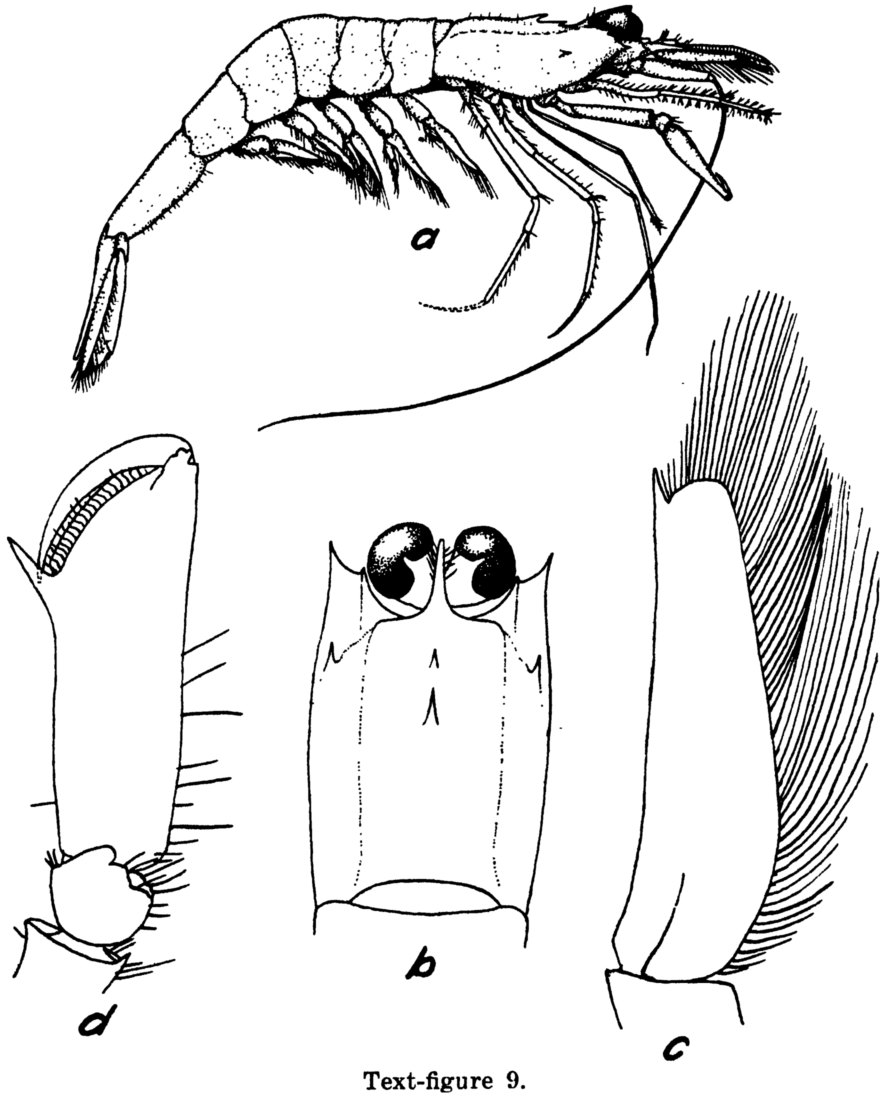
Diagnosis: Gastric region not depressed below general outline of carapace. Two spines on dorsal midline of carapace, the posterior in front of midpoint of carapace. A pair of lateral spines in line with anterior dorsal spine. Rostrum moderately ascendent, narrowly rounded at tip and not reaching as far forward as eyes. Abdomen with no carina on first five somites, sixth somite with parallel carinae divided by a median sulcus. Blade of antennal scale exceeded by outer spine. Chelae of first legs more than three times as long as wide.

Description: The carapace to the base of the rostrum is about one-fourth as long as the abdomen. The gastric region is not depressed below the general outline of the carapace. There are two spines in the dorsal midline, the posterior one much the longer and arising in front of the middle of the carapace. There is a strong lateral spine in line with the anterior dorsal one. On the anterior margin there are two spines, one at the lower orbital angle, the other at the antero-lateral angle of the carapace.

The rostrum ascends at a slight angle which varies somewhat, but never becomes as great as 45 degrees. It has a pronounced dorsal sulcus and tapers to a blunt point which never reaches as far forward as the eyes.

The abdomen is without trace of a carina on the first five somites. The posterior portions of the first two segments are slightly elevated, the elevations being preceded by broad, shallow, transverse sulci. The sixth segment, which is about one and two-thirds times as long as the fifth, bears a pair of dorsal longitudinal carinae separated by a median sulcus and bounded on the outer side by shallower sulci. The telson is longer than the sixth somite and bears two pairs of dorso-lateral spinules.

The eyes are large and black.



Text-figure 9.

Crago zacae, sp. nov. **a**. Female holotype. **b**. Dorsal view of carapace of holotype. **c**. Antennal scale of paratype. **d**. Hand of first leg of paratype.

The second segment of the antennular peduncle is about twice as long as the third. The flagella extend to the ends of the hairs which fringe the antennal scale. The latter is a little more than three and one-half times as long as wide and the outer spine easily exceeds the blade.

The third maxillipeds extend slightly beyond the antennular flagella. The first legs exceed the antennal scale but do not reach as far as the terminal fringe of the latter. There is a spine at the outer angle of the distal end of the merus. The palm is almost three and one-third times as long as wide and the dactyl closes quite obliquely. The second pair of legs is shorter than the first. The third pair extends well beyond the third maxillipeds and the fourth falls just short of the latter.

The eggs are of medium size.

The holotype is 20.5 mm. long, of which the carapace measures 3.7 mm. and the sum of the carapace and rostrum 4.8 mm.

Local Distribution: A total of 19 specimens was taken from east of Cedros Island (Station 125) and from Gorda Banks (Station 150) between 40 and 100 fathoms, on muddy and rocky bottoms.

Sex and Size: Five of the females, including the single specimen from Station 150, are ovigerous. They range in length from 20 to 26.5 mm. (carapace, 3.7 to 5.2 mm.). The non-ovigerous females are from 19.5 to 23 mm. long (carapace, 3.2 to 4.3 mm.). The males vary between 18 and 24.5 mm. in length (carapace, 3.3 to 4.5 mm.).

Color in Life: Body semi-translucent, mottled finely with greenish-brown and scarlet on dorsal and lateral surfaces; ventral surface white. Antennae banded with scarlet and white; eye mottled greenish and black; uropods and telson same color as body; remaining appendages translucent white.

Remarks: This species belongs to the group made up of *C. communis* (Rathbun), *C. resima* (Rathbun) and *C. abyssorum* (Rathbun). It is distinguished from the last by the smaller eyes, longer palm of the first leg and lack of a carina on the fifth abdominal somite. It differs from *C. resima* in the differently shaped and less ascendent rostrum and longer palm. The present species most closely resembles *C. communis*, which is supposed to range from the Bering Sea to San Diego, California. It apparently differs from that species in the total absence of a carina on any but the sixth segment of the abdomen. Also, although the palm of the first legs has about the same proportions as that of *C. communis*, the dactyl closes more longitudinally than in that species as figured by Miss Rathbun. Since all of the *Zaca* specimens are small and since the smallest of these show no trace of the parallel carinae on the sixth segment, it might be suggested that the other abdominal carinae had not yet become apparent. However, there are six male specimens of the same species in the Museum of Comparative Zoology which are from 34 to 39 mm. in length. They were collected at Monterey Bay, California, August 31, 1936, in 50 fathoms by Dr. Elizabeth Deichmann. These specimens agree in all particulars with the *Zaca* series and show no trace of a carina on any of the first five abdominal somites. Miss Rathbun (1904) mentions two specimens received from the Hopkins Laboratory at Pacific Grove which she referred to *C. communis*. It is probable that these were also dredged in Monterey Bay. Inasmuch as these two species are very similar in appearance, it may be that these specimens belong to *C. zacae*. Since this species has been taken at three such distant points as Monterey Bay, Cedros Island and Gorda Banks, future research may reveal that this is the southern form of *C. communis*.

Material: Station 125: D-1 (3 ♂, 15 ♀). Station 150: D-5 (1 ♀). Cat. Nos. 36,1096 (holotype); 36,1097 to 36,1099 inclusive (paratypes). One male and two female paratypes are deposited in the collections of the Museum of Comparative Zoology, Cambridge, Massachusetts (M. C. Z. Cat. No. 9,507).

9.

The Templeton Crocker Expedition. VIII. Polychaetous Annelids from the West Coast of Lower California, the Gulf of California and Clarion Island[1].

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Department of Zoology, Vassar College.

(Plates I & II).

[Note: This is the eighth of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica,* No. 2, pp. 33 to 46.]

CONTENTS.

[1]Contribution No. 527, Department of Tropical Research, New York Zoological Society.

INTRODUCTION.

The following is a taxonomic account of 34 species of polychaetous annelids collected by Dr. William Beebe on the Templeton Crocker Expedition in 1936. Seven new species are included in the collection.

The catalogue numbers all refer to specimens in the collections of the Department of Tropical Research of the New York Zoological Society.

SYSTEMATIC ACCOUNT.

Family Amphinomidae.

Eurythoe Kinberg.

Eurythoe pacifica Kinberg.

Eurythoe pacifica Kinberg, 1857, p. 14.

Collected under stones, Sulphur Bay, Clarion Island, and at Station 163: D-1 (Clarion Island, 20 fathoms). Cat. Nos. 36,627 and 36,595.

Family Polynoidae.

Lepidonotus Leach.

Lepidonotus coelorus[2] Moore.

Lepidonotus coelorus Moore, 1903, pp. 412-414; pl. 23, fig. 12.

Moore later recorded this species from the northern Pacific coast of the United States (1908, p. 331); Treadwell (1914, p. 182), listed it from San Diego, San Pedro and San Clemente Is., California, and Chamberlin (1919b, p. 252) recorded it from San Francisco, California and Gulf of Georgia, State of Washington. Chamberlin included in this species *L. squamatus* as identified by Treadwell (*loc. cit.*, p. 181) and by Johnson (1897, p. 166), without, so far as appears from the record, having reexamined the material. If his identification is correct, *L. squamatus* has not been found on the Pacific coast.

Collected at Station 136: D-1 (Arena Bank, 45 fathoms). Cat. No. 36,178.

Lepidonotus pilosus sp. nov.

(Plate I, Figures 1-7).

A single specimen 43 mm. long and 17 mm. wide when measured to the ends of the setae. The median vertical diameter is 8 mm. at the thickest portion, hence the general effect is that of a thick-bodied animal. The twelve pairs of elytra completely cover the dorsal surface and because of their numerous spines and filaments arranged both laterally and on the surface, give the animal an unusually shaggy appearance. The elytra are light brown in color, the body iridescent pearly-gray on both dorsal and ventral surfaces. There are no dorsal tubercles. Nephridial tubercles first appear on the sixth setigerous somite, being at first very small but gradually increasing in length until posteriorly they are more than one-half as long as the ventral cirri. They are absent on the last setigerous somite. All anal cirri were lost.

The prostomium (Fig. 1) has its greatest width (1½ mm.), about equal to its length as far as to the bases of the tentaculophores. The anterior eyes are situated at the level of the greatest diameter and from this point the lateral margins slope about equally in both directions to the anterior and posterior ends. The anterior eyes are larger than the posterior, the latter lying definitely on the dorsal surface and at some distance from the posterior prostomial margin. In the preserved specimen a prominent lobe from the anterior margin of the first somite covers the prostomium to a point in front of the posterior eyes. When this lobe is lifted off a narrow isthmus can be seen connecting the prostomium with the first somite

[2]Moore spelled this *coelorus* in the original description. Later Moore, Treadwell and Chamberlin recorded it as *coeloris*. (Citations above.)

(Fig. 1). The tentacles were all lost. The lateral tentaculophores are anterior continuations of the lateral lobes of the prostomium and are about one-half as long as it is. The median tentaculophore is a little heavier than the laterals and is inserted in a basally rounded notch on the anterior prostomial margin. The dorsal surface of the prostomium is perfectly smooth, there being no indication of a median longitudinal cleft. The cirrophores of the tentacular cirri extend about as far as that of the median tentacle and only the right ventral style remains. This is slender and mainly colorless but has one colored band about two-thirds of its length from the base and another near the apex. The apex was covered with detritus which for fear of breaking the style I did not attempt to remove, but probably it is similar to the dorsal cirrus of the first parapodium, which is swollen near the end and terminates in a filament. However neither this nor later dorsal cirri has the medial pigment band. The palps are heavy, brown in color and about three times as long as the prostomium measured to the ends of the tentaculophores. Under a magnification of about 40 diameters they and the tentaculophores may be seen to be thickly studded with short, sharp-pointed spines.

When the elytra are removed the most noticeable features are the elytrophores and the gills. The former are very prominent, the oval scar of attachment of the elytron measuring 1.5 mm. in longest diameter. The gills both simple and branched occur sparingly on the posterior faces of the parapodia but are especially prominent on the dorsal and anterior surfaces. Usually a large three-branched one is attached to the lateral margin of the elytrophore (Fig. 2) and a dense mass of smaller ones fills the space between this and the end of the parapodium as well as covering the anterior face of the latter. On cirrus-bearing parapodia the gills lie mesially to the cirri but in other respects they do not differ from the others. In some posterior somites the gills are fewer on the dorsal but more numerous on the posterior parapodial faces.

In the parapodium the neuropodium (Fig. 2), is very thick and fleshy and has a rounded posterior lip and a pointed anterior one, into which the acicula extends. There are no tubercles but very definite wrinkles which seem not to be wholly due to the preservation methods. A tuft of twenty or more dark-brown setae lies posterior to the acicula. The notopodium is composed of a rounded posterior elevation in which is located a tuft of very fine setae and an anterior finger-shaped process from the end of which protrudes the acicula. The style of the ventral cirrus is an elongated narrow cone which reaches not quite to the end of the notopodium. The dorsal cirri extend beyond the apices of the neurosetae, and are slender, colorless except for a pigment band proximal to the subterminal swelling, and have fine filamentous tips.

The anterior pair of elytra completely cover the prostomium. They are broad-oval, nearly circular in outline and carry a densely packed row of filaments around their entire margins. The longest of these filaments are on the anterior and lateral margins and are as long as one-quarter of the diameter of the elytron. Posterior to the point of elytron insertion are numerous small brown papillae either sessile or on very short stalks, the terminal portion conical and covered with spines (Fig. 3). These occur on about one-third of the posterior surface of the elytron. On the remainder of the elytron are spines of a different sort, generally brown in color and of widely varying sizes. From an end view these appear to be circular but occasionally one is bent over showing an hour-glass form (Fig. 4), the rounded end densely studded with small spines. The one drawn was one of the smallest, many having diameters four or five times as great as this. Along the anterior, median and posterior borders of the region of the elytrophore attachment the elytron is elevated into a ridge on whose summit are as many as thirty of these papillae, some of which are colorless. Near the base of this ridge are fine hair-like fila-

ments on the elytral surface. Later elytra vary somewhat in outline but are all more or less alike (Fig. 5). On the narrower end (marked off by the dotted line) where each is overlapped by the preceding one, there are no marginal filaments and none of the larger papillae. A narrow line along the margin of this area is translucent and spineless while over the remainder occur the conical papillae. Around the remainder of the elytron is a dense marginal tangle of filaments and similar filaments occur along the elytrophoral ridge mentioned above, which is present in all elytra. Filaments occur over the general elytron surface but are smaller, sometimes smaller than the papillae of the hour-glass type which are numerous on the surface. When in position the elytra with their papillae and hairs give the dorsal surface a decidedly hairy appearance.

The neuropodial setae are very large and dark-brown in color. Each (Fig. 6) has a terminal tooth at whose base is a collection of sharp-pointed, transparent spines. I was unable to determine any regularity in the arrangement of these spines. The notopodial setae form a fan-shaped tuft which extends as far as to the ends of the neurosetae. They are thread-like and of varying diameters, but never very heavy, and carry two rows of plates (Fig. 7). Cross lines from one side of the stalk to the other at the level of the plates do not indicate rows of plates.

Collected at Station 136: D-13 (Arena Bank, 45 fathoms). Cat. No. 36,382. Type in the collections of the Department of Tropical Research, New York Zoological Society.

Halosydna Kinberg.

Halosydna obtusa-cirrata sp. nov.

(Plate I, Figures 8-11.5).

The type specimen is 25 mm. long and measures 9 mm. across the back from tip to tip of setae. The prostomium has its greatest width (1 mm.) at the point of location of the anterior eyes, about half way along its lateral margin (Fig. 8). The posterior eyes lie near the posterior prostomial margin and in the preserved material are partly covered by the anterior margin of somite 1. The lateral prostomial margins are smoothly rounded and bend inward anteriorly to the bases of the tentaculophores. These are slender and about one-half as long as the prostomium posterior to their point of origin. The median one is slightly wider than the laterals and is inserted in an angular depression from which a fine line runs posteriorly for a short distance on the dorsal prostomial surface. The left lateral tentacle is the only one preserved. This (Fig. 8) is about twice as long as the tentaculophore and slender. Near the apex is a slight swelling and beyond this an unusually long filament. There is a pigment band just proximal to the swelling and at about the middle of the style a diffuse scattering of pigment spots. In the type the palps are badly shriveled but in the other specimen they are about three times as long as the prostomium and have filamentous ends. A band of pigment lies a short distance behind the end and a dusting of pigment occurs over their basal halves. The cirrophores of the tentacular cirri extend beyond that of the median tentacle. The left ventral style is the only one remaining. This is about one-quarter larger than the tentacle and is similar to it in form and markings. The protruded pharynx is about as long as the first nine somites. Apically, it has nine papillae both dorsally and ventrally and two pairs of brown jaws. Its surface is smooth.

The peristomium is rather more than three times as wide and its elytrophores about one-third as wide as the prostomium. There are eighteen pairs of elytra in contact or partially overlapping on the dorsal body surface and overlapping on the sides for nearly one-half of their diameters.

The first two pairs completely cover the prostomium. Elytra from the anterior end of the body (Fig. 9) are reniform with one end broader than the other. On the anterior border of each is a thin, colorless strip and posterior to this a collection of brown pigment running transversely. This pigment is densest near the mid-dorsal end of the elytron, much thinner at the outer end and extends for about one-half of the elytron length. Thus it is largely covered by the overlapping elytron in front of it. The posterior half of the elytron is mostly without pigment but there is a narrow band a short distance inside the posterior margin and a dark patch lies just over the elytrophore attachment. Light brown spines are scattered over the entire surface (detail Fig. 10), and on the lateral margin is a row of prominent filaments. There is along the body a gradual change in the form of the elytra from reniform to approximately round.

The parapodia (Fig. 11) have heavy, pointed neuropodia and very small notopodia, the latter hardly more than small lumps on the neuropodial surface. A small acicula is present in the notopodium and a much larger one in the neuropodium. On somites that do not carry elytra are pseudoelytrophores, prominent pads in line with the true elytrophores. Lateral to these (Fig. 11) are structures which at first seemed to be large cirrophores of the dorsal cirri from which the styles had been lost. When the specimen reached me the elytra were all in place, thus in a position to protect dorsal cirri from injury but no styles were found on either specimen. The thick structure shown in Fig. 11, lying lateral to the pseudoelytrophore, is the dorsal cirrus which is swollen at the base and bluntly rounded at the end. They differ in size, the longest extending beyond the setal lobe. The ventral cirrus is slender and extends almost to the end of the neuropodium.

The neurosetae (Fig. 11.5) are all of one kind and about twenty in a tuft. They are heavy, light-yellow in color and are slightly enlarged toward the apices, narrowing from this to a blunt point. Rows of toothed plates lie on the concave part of the curved region. The notopodial setae form a fan-shaped tuft close under the dorsal cirrus. They are colorless, very long, slender and sharp-pointed. The stalks are longitudinally striated and carry a large number of finely-toothed plates in two rows.

In the type the prostomium is colored a uniformly light brown on which the dark eyes are very prominent. On the dorsal surface of each somite is a transverse brown band, the remainder of the surface being colorless. In the type the nephridial papillae first appear on the seventh setigerous somite.

Collected at Station 126: D-3 (East of Cedros Island, Lower California, 40 fathoms). Cat. No. 36,637.

The type is in the collections of the Department of Tropical Research of the New York Zoological Society. The co-type is in the American Museum of Natural History.

Lepidasthenia Malmgren.

Lepidasthenia pulchra Johnson.

Polynoe pulchra Johnson, 1897, pp. 177-179; pl. 7, figs. 34, 43, 43a; pl. 8, figs. 50, 50a, 50b.

Johnson recorded the elytra as faintly marked with brown or else immaculate. Most of those in this collection were colorless over the left anterior quadrant and diffusely marked with brown over the remainder. Johnson found occasional setae in the notopodia but said they are often absent from this part of the parapodium. I was unable to find any in the notopodia I studied.

While there may be some asymmetry in the arrangement of cirri and elytra, the location of elytra on every third somite after the twenty-third is generally regarded as characteristic of *Lepidasthenia* and Munro (1924, p. 43) proposed a new genus *Lepidastheniella* to include those in which these

later elytra lie on alternate somites. Johnson's specimens had elytra (after the twenty-third somite) on somites 23, 26, 28, 29, 31 --- 51. He did not record those between 31 and 51. In my specimen they are on 23, 25, 26, 28, 29 and on alternate somites posterior to this. Strictly speaking therefore, neither Johnson's specimen nor mine belongs in either of the above genera. In view of the frequent variability in this elytron arrangement it seems wiser to retain *Lepidasthenia* as the generic name.

One entire specimen was collected at Station 128: D-1 (East of Cedros Island, Lower California, 39 fathoms). A fragment of the anterior end was found at Station 127: D-1 (same locality, 38 fathoms). It was recorded as taken in an echinoderm test.

Cat. Nos. 3,698 and 36,105.

Lepidasthenia fragilis Johnson.

Polynoe fragilis Johnson, 1897, pp. 179-181; pl. 7, figs. 36, 45; pl. 8, figs. 52, 52a, 52b.

One much mutilated specimen retaining only about forty-five somites of the anterior end. All elytra and most dorsal cirri are lost. I have identified it from its correspondence with Johnson's description of the head, parapodia and setae. In the original description Johnson noted that the ventral cirri are lacking but in a later paper (1901, p. 390), he recorded them as occasionally present. In my specimens they appear as flattened oval plates.

Collected at Station 126: D-3 (East of Cedros Island, Lower California, 40 fathoms). Cat. No. 36,637a.

Lepidasthenia ornata sp. nov.

Plate I, Figures 12-15).

The collections contained two specimens, one of which, the type, is a mature male. It is 50 mm. long and has a maximum width of 4 mm. It is entire and composed of about one hundred somites. The other is a mature female about one-quarter larger than the type and is incomplete, retaining only about seventy-five anterior somites. The elytra have the usual arrangement and continue to the extreme posterior end of the body. I was unable to discover any somites having an elytron on one side and cirrus on the other, a condition described as characteristic of this genus.

The anterior half of the body is deeply pigmented in dark brown and in life must have made a brilliant showing. This pigmentation covers only the dorsal surface of the somites, leaving all cirri and parapodia uncolored. In the type there is a minute pigment patch at the base of the cirrophore of the tentacular cirri and another on the anterior face of the first parapodium. A rectangular patch lies on the mid-dorsal line of somites 2 and 3 and on each of these are narrow lateral patches. On somites 4 and 5 this pigment widens to form on either side an irregular line, the two uniting in a narrow patch on the anterior face of somite 4 and spreading across the posterior part of 5, leaving a large colorless patch on the dorsal surfaces of both somites. Somite 6 has a lighter pigment patch on the mid-dorsal line and a darker area on either side. Somite 7 has a dorsal patch similar to that on 6 and in addition an irregular darker area extends across its anterior margin and widens on either side so as to cover nearly all of the lateral surfaces; 8 is nearly colorless but has pigment on its dorsal surface and darker areas near the parapodial bases. The following three somites are almost completely covered with dark pigment but on either side is a colorless spot about half-way between the parapodium and the mid-dorsal line. The following eight somites are pigmented and alternate in having a large and a small colorless patch on either side of the mid-dorsal line. Behind this there is an approximation to this alternation but it soon becomes irregular and

throughout the posterior half of the body the most noticeable features are two colorless patches, one on either side of the mid-dorsal line; a small brown spot on either side in each somite forming a longitudinal line and the ocellae on the elytra.

Each half of the prostomium (Fig. 12) is flask-shaped with the inner "shoulder" a trifle higher than the outer and there is a definite emargination on the posterior margin. The median tentacle is a trifle longer than either lateral but in other respects they are similar. Each has a slender style which very slightly widens near the apex and terminates in a rather long filament. The palps are not very prominent and taper uniformly to a sharp apex which extends a little beyond the end of the median tentacle. The tentacular cirri in the type are smaller than the tentacle. In the other specimen there is asymmetry in that one of these cirri is larger than the others and the tentacle. The eyes lie in the usual position, the anterior, which are larger, lying near the lateral margin, the posterior ones farther back. The anterior ones have definite lenses. The protruded pharynx has a smooth surface and carries nine marginal papillae above and below the mouth in which, above and below, is a tooth composed of two unequal fangs.

In the type the left anterior elytron remained and covered the head region as far as half-way on the tentacular styles. It was broad and must originally have overlapped its mate on the opposite side. The second elytra are much smaller and reach only to the elytrophore of the first. The third reaches to about the middle of the second but the two of this set do not meet dorsally. Later ones are still smaller, leaving fully one-half of the mid-dorsal region of the body uncovered and overlapping one another only slightly. The single first elytron was lost in transferring the specimen but all others are approximately circular in outline and have smooth margins. They are translucent, but numerous spots of a whitish appearance are scattered over their surfaces. Not so noticeable anteriorly but very prominent through most of the body is a pigment ring or ocellus surrounding the area of attachment to the elytrophore on each elytron.

In both specimens the posterior parapodia are distended with sex products but I cannot say how far their structures may have been modified by this condition. The seventh (Fig. 13) has a heavy setal lobe obliquely truncated at the apex. There is a heavy neuropodial and a smaller notopodial acicula but there are no setae in the notopodium. The dorsal cirrus is relatively large and terminates in a fine filament; the ventral cirrus is flask shaped. In the 75th parapodium the dorsal region is much enlarged and is filled with sex products and the dorsal cirrus short and acutely and asymmetrically conical. The setal portion shows two distinct lips at its end, one being slightly shorter than the other, and there are two aciculae. (Fig. 14).

Contrary to the condition in other species of this genus, which in some respects resemble this one, only one kind of seta occurs in any parapodium and they are similar throughout the body. Each (Fig. 15) has a long stalk which widens very slightly in the region of attachment of the lateral plates, and a terminal and subterminal tooth. On the wider portion each carries two rows of plates. The only difference between setae from different parts of the body are that the stalks of the posterior ones are a trifle heavier and the number of toothed plates smaller than in anterior somites.

The anal cirri are moderately long and conical and have filamentous tips. They are covered for about one-half their length by the last pair of elytra.

From the fact that terebellid tentacles were found tangled in the parapodia I infer that the species is commensal with some member of that family.

This species seems to be closely related to *L.* (*Polynoe*) *gigas* Johnson (1897, pp. 172-175; pl. 7, figs. 23, 42, 42a; pl. 8, figs. 48, 48a, 48b, 49) but differs from it in the character of the cirri, setae and coloration.

The type was collected at Station 136: D-12 (Arena Bank, 35 fathoms) and is No. 36,377 in the collections of the Department of Tropical Research of the New York Zoological Society. Others were collected at Station 136: D-13 (Arena Bank, 45 fathoms). Cat. Nos. 36,377 and 36,382.

Family Aphroditidae.

Aphrodita Linnaeus.

Aphrodita castanea Moore.

Aphrodita castanea Moore, 1910b, pp. 380-385; pl. 32, figs. 85-97; pl. 33, fig. 98.

The prostomium with its short, clubbed, median tentacle and long palps studded with spines is exactly as stated for this species by Moore. The only details in which there are disagreement are the length of the ventral cirri which reach only to the base of the ventral setae; the form of the fimbriate organs which are relatively shorter and more elevated than in Moore's specimens; and the fact that the setae have smooth rather than hirsute ends. These seem to be varietal rather than specific differences.

One specimen collected at Station 126: D-4 (East of Cedros Island, Lower California, 40 fathoms). Cat. No. 36,645.

Chloeia Savigny.

Chloeia entypa Chamberlin.

Chloeia entypa Chamberlin, 1919a, pp. 30, 31; pl. 13, figs. 8, 9; pl. 14, figs. 1, 2.

Chamberlin diagnosed this species from a single specimen 10 mm. long and 4.2 mm. wide. In the present collection are two specimens of nearly equal size, one being 70 mm. long and 15 mm. wide. In all details except setae they agree with Chamberlin's description. The exception is that all setae taper uniformly toward the ends while in the original diagnosis they are said to bifurcate. Some of the dorsal setae have the rather coarse marginal denticulations figured by Chamberlin (1919a, pl. 14, fig. 1) as occurring on the larger of the two terminal branches. In spite of this difference I have tentatively included my material in this species. In view of the size differences between the specimens it is possible that these may be differences due to age.

Collected at Station 135: D-11 (Shallow water of San Lucas Bay, 6 to 11 fathoms) and under stones on the shore of Santa Inez Bay. Cat. Nos. 36,221 and 36,570.

Family Acoetidae.

Panthalis Kinberg.

Panthalis adumbrata Hoagland.

Panthalis adumbrata Hoagland, 1920, pp. 606-607; pl. 46, figs. 9-14.

Only the anterior ends of two broken specimens are present in the collection. In the better preserved of the two, while the median tentacle is inserted at the level of the ommatophore base a longitudinal ridge of the same diameter as the tentacle runs posteriorly along the dorsal prostomial surface to meet a transverse ridge which crosses the surface at about one-third its length from the posterior border. The general effect is that the

tentacle seems to rise at the level of this transverse ridge. As noted by Hoagland, this species seems to be closely related to *P. panamansis* of Chamberlin (1919a, pp. 86-89; pl. 11, figs. 4-8; pl. 12, figs. 1-6).

Collected at Station 136: D-4 (Arena Bank, 55 fathoms) and at Station 143: D-4 (Santa Inez Bay, 55 fathoms). Cat. Nos. 36,283 and 36,353.

Family Phyllodocidae.

Anaitides Czerniawsky.

Anaitides minuta sp. nov.

(Plate II, Figures 16-18).

A single specimen from which the posterior end has been lost. What remains is 45 mm. long and at its widest portion, near somite 15, is 2 mm. wide. Since the posterior end of the fragment is very narrow it seems probable that only a small part is missing.

The prostomium (Fig. 16) has a basal width slightly greater than its length, the proportions being about as 1 to 0.9. The eyes are very large, each nearly one-quarter as wide as the prostomium, and are situated at the posterolateral prostomial angles. They are dark brown in color with a central area of a lighter brown. Immediately in front of each eye the prostomium narrows and this narrowing continues uniformly to the anterior end. There is a definite emargination on the posterior margin but I could find no indication of a nuchal cirrus. The tentacles are acutely conical, subequal in size and rather less than one-third as long as the prostomium. On either side of the base of the protruded pharynx are six short rows of sharp papillae. Beyond these on either side are three rows of larger papillae having very poorly defined outlines. The extreme end of the pharynx was not exerted. There are four pairs of moderately prominent tentacular cirri on somites 1, 2 and 3. On either side of somite 1 is a single cirrus whose style reaches to somite 4; somite 2 has two on a side, the dorsal one reaching to somite 10, the ventral one to 4. The style of the ventral one is larger than that of the dorsal. Somite 3 has one on a side, its style reaching almost as far as the dorsal one on somite 2.

After the first four or five the somites are biannular, the anterior ring being very short. The parapodia are attached to the posterior ring. The general body color is a yellowish-brown with a fine dusting of black. In the anterior region this dusting is irregular on the dorsal surface but posteriorly it tends to be limited to the intersomitic constrictions.

The parapodium (Fig. 17) has a conical setal lobe having a bifid anterior and a conical posterior lip at its apex, the anterior one being the longer. The dorsal cirri are not prominent and would not be able to overlap if brought together over the dorsal body surface. In the preserved specimen they are held parallel to the longitudinal body axis and well away from contact with the body. Each is long enough to touch the parapodium of the second somite behind the one to which it is attached. Each cirrus is asymmetrically ovate in general outline and has an acute apex. The ventral cirrus is much shorter than the dorsal and is blunt ended but in general has a similar outline.

The setae (Fig. 18) have an unusual development of spines on the apex of the basal joint, and the terminal joint is noticeably toothed especially near its base.

Collected at Station 136: D-12 (Arena Bank, 35 fathoms).

This type is No. 36,377 in the collections of the Department of Tropical Research, New York Zoological Society.

Family Nephthydidae.

Nephthys Cuvier.

Nephthys dibranchis Grube.

Nephthys dibranchis McIntosh, 1885, pp. 161-162; pl. 27, fig. 5.

A number of species of this genus have been recorded from the Pacific coast but Moore (1911, p. 243), after an exhaustive study of this material, decided that they all belong to *N. coeca* (Fabricius) Oersted. *N. dibranchis* differs from this in the possession of a slender cirrus-like branchia on the dorsal surface of the neuropodium in addition to the much heavier coiled one on the notopodium. In prostomial structure the specimens listed here agree more closely with McIntosh's *N. verrilli* (*loc. cit.*, pp. 163-164; pl. 26, figs. 6, 7; pl. 32A fig. 8), but Munro (1933, p. 56), reported after a reexamination of the type of *N. verrilli* that it is synonymous with *N. dibranchis.*

Collected at Station 126: D-2 (East of Cedros Island, Lower California, 38 fathoms); Station 126: D-9 (same locality, 87 fathoms), and Station 136: D-4 (Arena Bank, 100 fathoms). Cat. Nos. 3,684, 36,653 and 36,353.

Family Hesionidae.

Hesione Savigny.

Hesione panamena Chamberlin.

Hesione panamena Chamberlin, 1919a, pp. 188-190; pl. 22, figs. 9, 10.

A single specimen lacking tentacular, anal and all dorsal cirri. Traces of longitudinal pigment lines remain in anterior somites but mostly the body is colorless. The prostomium is broader than long and the anterior eyes have twice the diameter of the posterior. The anterior and posterior eyes are separated by about the diameter of the posterior ones from one another, the anterior being a trifle farther apart than the posterior. The setae agree with Chamberlin's description. Munro (1928, p. 79) has listed this species as synonymous with Grube's *H. intertexta.* While in coloring Chamberlin's specimen agreed with Grube's diagnosis (1878, pp. 102, 103; pl. 6, fig. 5) the two seem to differ in other respects. Chamberlin stated that the antennae had been broken. In my specimen there are no antennae and no trace of their presence. In Grube's Figure 5 definite antennae are shown. It is possible that in my specimen and in Chamberlin's no antennae occur. The character of the prostomium is much more like that in Chamberlin's description than that of Grube's. Tentatively I am retaining *H. panamena* as a valid species.

The protruded pharynx is about as long as the prostomium and first somite taken together. Its basal portion is thin-walled and is wider than the prostomium but has a constriction at the base. The terminal portion is about one-half as long as the basal and has a denser wall. Its apical margin is recurved and carries numerous fine short filaments.

Collected at Station 163: D-1 (Sulphur Bay, Clarion Island, 20 fathoms). Cat. No. 36,595a.

Family Nereidae.

Nereis Linnaeus.

Nereis ambiguus sp. nov.

(Plate II, Figures 19-24).

Two specimens, one of which had lost its posterior end, are in the collection. The larger one, the type, is 25 mm. long and 1 mm. in prostomial

diameter. The prostomium (Fig. 19) is a trifle wider than long and narrows sharply just in front of the anterior eyes to widen a trifle at the anterior lateral angles where the tentacles are attached. The tentacles are relatively rather stout and are separated at their bases by less than one-half their diameter. Their length is about one-half that of the prostomium. The basal joint of the palps is heavy, the terminal joint globular, and does not quite reach the end of the tentacle. The longest tentacular cirrus is the posterior dorsal one which reaches as far as the ninth somite. The anterior dorsal is a little more than half as long as this, the ventral ones much shorter. The peristomium is shorter than the prostomium and about twice as long as somite 2. Between the eyes there is a noticeable emargination of its anterior edge. Aside from the parapodial pigment the only trace of color in the specimen is a very little brown at the bases of the tentacles and two longitudinal bands running posteriorly from the anterior peristomial border in a line with the posterior eyes.

In neither specimen was the pharynx protruded and an attempt was made to get the dental formula by dissection. Since the vertical diameter of the peristomium was about 1 mm., this attempt was not wholly successful but the best I could do is I, absent; II, absent; III, a tuft of about 8 on either side; IV, 3 in a transverse row; V, absent; VI, 3 or 4; VII, 7 or 8 very long and blunt pointed ones on either side, having irregular ones in front of them; VIII, a circular patch of about 20. Some of the paragnaths are very prominent and all are dark brown in color. The jaws are large, hardly colored except that along the concave margin of the apex and the teeth there is a light brown tint. On the margin are nine teeth.

The type retained only one anal cirrus. This is relatively heavy and long, as long as the last seven body somites.

Anterior parapodia (Fig. 20 of the 8th) have the notopodial lobes and the ventral lobe of the neuropodium very bluntly rounded, the lip into which the neuropodial acicula protrudes being sharp-pointed. The dorsal cirrus is slender and extends for about one-half its length beyond the notopodium. The ventral cirrus is shorter than the neuropodium. At the base of the dorsal cirrus is a small pigment spot but there is no definite pigmentation elsewhere, although the thickness of the organ makes it opaque. There are two aciculae. In posterior parapodia (Fig. 21), the parapodial lobes become very sharp-pointed and are noticeably filled with pigment, giving a characteristic appearance to the animal as a whole. This pigment completely fills the two notopodial lobes and the ventral one of the neuropodial. Both dorsal and ventral cirri are short, neither quite reaching the end of the parapodium.

In anterior parapodia the setae of the notopodium occur in tufts of about six. They are slender and uncolored, each (Fig. 22) having a camerated homogomphous basal joint and a long, slender terminal one with a row of spines along one border. There is some variation in the lengths of these terminal joints even when the basal are of the same length. The neuropodial setae are of three kinds. Dorsal to the acicula are some like those of the notopodium and lying posterior to these are heavier ones (Fig. 23) that are heterogomphous and carry short blunt-pointed terminal joints that have a row of prominent spines along one concave border. Ventral to the acicula are a third kind similar to the dorsal ones except that they are heterogomphous, together with some of the heavier ones shown in Fig. 23. In all of the posterior parapodia examined there was one heavy seta in the notopodium. This (Fig. 24) is camerated like all of the others and is homogomphous, carrying at its end a terminal joint deeply mortised into the basal. This form of seta is common in *Nereis* but this is unusual in that instead of being lens-shaped with smooth margins it has a row of spines along one edge and its end is rounded. There is never more than one of

these setae in a parapodium and it is either the only one there or it is accompanied by one of the slender ones like Fig. 22. The neuropodial setae are like those farther forward except that in the heavier ones the terminal joint is shorter.

In the form of the parapodium this species resembles *N. neonigripes* Hartman (1936, pp. 471, 472; figs. 48 a-g), but the two differ in the relative length of the tentacular cirri and in the posterior notosetae. So far as my imperfect dissection could determine they also differ in tooth formula. In this last respect *N. ambiguus* resembles *N. procera* Ehlers but in other details it is different from that species. The structure of the head is different as are also the posterior notosetae and Ehlers says that in *N. procera* the paragnaths are small and difficult to see. In *N. ambiguus* they are prominent.

Collected at Station 163: D-1 (Sulphur Bay, Clarion Island, 20 fathoms). This type is No. 36,595 in the collections of the Department of Tropical Research, New York Zoological Society.

A specimen of a heteronereis is in the collection labeled Cat. No. 36,883. "Taken at night light, off Avalon, Santa Catalina Id."

Family Leodicidae.

Leodice Savigny. (Eunice Cuvier).

Leodice has priority but because of long usage some annelid taxonomists prefer *Eunice*. The revival of *Leodice* is not as recent as some have implied, since it was used by Malmgren in 1865 and by Verrill in 1885.

Leodice 1. sp?

The only specimen is a fragment of the posterior end of a single individual, the fragment being 107 mm. long and 7 mm. wide. In the peculiar form of the sub-acicular setae and end of the acicula and in the fact that the gills extend to the pygidium, this agrees with a specimen Munro (1933, pp. 65-66; fig. 27 a-b) identified as *Eunice filamentosa* Quatrefages collected in Galápagos. In this note Munro apparently claims that *Eunice* (*Leodice*) *filamentosa* is synonymous with *E. denticulata* Webster. Having collected considerable numbers of *denticulata* and a few of *filamentosa* I am unable to agree with Munro on this point. *Denticulata* is several times as large as *filamentosa* and lives in a branching parchment tube which extends through the body spaces of a sponge, while *filamentosa* never builds such tubes. The two differ in almost every detail of structure (*See* Treadwell, 1921). I have reexamined a specimen of *denticulata* collected by myself and now in the American Museum of Natural History and find that in details of aciculae and setae it agrees with the Lower California specimen. It also agrees with Munro's description. It seems quite probable that both Munro's specimen and mine are *denticulata*.

Collected at Station 136: (Arena Bank, from coral, in 2½ fathoms). Cat. No. 36,882.

Leodice 2. sp?

A fragment 80 mm. long and 15 mm. wide, measured to the ends of the setae. It shows very great similarities to *Eunice* (*Leodice*) *multipectinata* of Moore (1911, pp. 248-251; pl. 15, figs. 20-23), and very possibly may be of that species.

Collected at Station 141: D-1 (Santa Inez Bay, 7 to 9 fathoms). Cat. No. 36,206.

Arabella Grube. sp?

A single much mutilated fragment of the anterior end. From prostomium, maxilla and seta structure it is recognisable as *Arabella* but further identification is not possible.

Collected at Station 127: D-1 (East of Cedros Island, Lower California, 38 fathoms). Cat. No. 3,692.

Lumbrinereis de Blainville. sp?

A fragment of the posterior end of a *Lumbrinereis* was taken at Station 147: D-2 (Santa Inez Bay, 60 fathoms). Cat. No. 36,335.

Diopatra Grube.

Diopatra californica Moore.

Diopatra californica Moore, 1904, pp. 484-487; pl. 37, figs. 1-9.

One incomplete specimen 15 mm. long, retaining only the prostomium and thirty anterior somites. Moore stated that the spiral arrangement of the gill is lost on the thirtieth somite. In this specimen that structure appears on that somite but since this is the last somite retained in the fragment I cannot say what the condition would be in later gills. Other (probably minor) differences from Moore's account are that the gills begin on the fifth instead of the fourth somite and their basal parts show no ringing.

Collected at Station 155: D-1 (13 miles west of Mazatlan, 56 fathoms). Cat. No. 36,473.

Hyalinoecia Malmgren.

Hyalinoecia juvenalis Moore.

Hyalinoecia juvenalis Moore, 1911, pp. 277-280; pl. 18, figs. 86-95.

Provisionally listed with this species although simple setae occur with the compound in earlier somites than as described by Moore and the maxillae are rather more strongly hooked.

Collected at Station 136: D-4 (Arena Bank, 55 fathoms). Cat. No. 36,353.

Fragments of tubes belonging either to *Onuphis* or *Diopatra* were taken at Station 136: D-5 (Arena Bank, 33 fathoms). Cat. No. 36,359.

Family Glyceridae.

Glycera Savigny.

Glycera rugosa Johnson.

Glycera rugosa Johnson, 1901, pp. 409-411; pl. 10, figs. 101, 102.

Several specimens, some immature. I have based the identification on the form of the prostomium and parapodium. The latter are proportionately smaller than as described by Johnson.

Collected at Station 125: D-1 (East of Cedros Island, 44 fathoms); Station 126: D-6 (same locality, 45 fathoms); Station 147: D-2 (Santa Inez Bay, 60 fathoms). Cat. Nos. 3,672, 36,335 and 36,648.

Family Cirratulidae.

Cirratulus Lamarck.

Cirratulus exuberans Chamberlin.

Cirratulus exuberans Chamberlin, 1919b, pp. 263, 264.

Collected at Station 159: T-2, in tidepool. Cat. No. 36,489.

Cirratulus inhamatus sp. nov.

(Plate II, Figure 25).

A single specimen 85 mm. long, its greatest width 7 mm. The basal width of the prostomium is 1 mm.

The prostomium (Fig. 25) is conical, overlapping and bounding laterally the prominent mouth. An uncertain number of somites compose the remainder of the head region. Dorsally no somite boundaries can be seen while ventrally there are indications of at least four. On either side near the posterior margin is a region bounded by a shallow ditch and bearing on its end scars where branchiae have been attached. It is difficult to say how many of these there were but probably the number was about five. Approximately the thirty somites following the head are extremely short, and following ones are fully twice as long as these, there being not more than two of an intermediate length. This latter condition continues to the posterior end of the body. The pygidium has been lost. Most of the lateral gills are lost but evidently were originally present on most somites. Some of those remaining are very small, looking like hardly more than cirri. Because so many are absent it is impossible to tell whether there originally was an alternation of long and short gills. Capillary setae begin on the first short somite behind the head. Except that anterior ones are longer than the posterior, they are all alike, the longest equal in length to one-half the body width. The notopodial and neuropodial setae are separated by only a short distance.

Collected at Station 126: D-4 (East of Cedros Island, 40 fathoms). Type No. 36,645 in the collections of the Department of Tropical Research of the New York Zoological Society.

This species in many respects resembles *C. sinincolens* of Chamberlin (1919a, pp. 377-379; pl. 70, figs. 7-10), also taken in the Gulf of California, but differs in the form of the head, in the location of the special branchiae on the somite in front of the first setigerous rather than on that somite and in the character of the setae. While both species lack the heavy spines generally found in this genus, *C. sinincolens* has in posterior somites a single stout neuropodial seta which Chamberlin thought represents the crochet. There is no trace of this form of seta in *C. inhamatus*. Also in the former species Chamberlin describes two kinds of capillary setae of which the larger has serrations along one margin. In the latter are finer and coarser capillary setae but there is no trace of serrations on either. Also the relative sizes of the somites in different parts of the body is not as described by Chamberlin.

Several other specimens belonging to this family are in the collection but because of poor preservation it is not possible accurately to identify them. They appear to have no dorsal filaments, which would seem to put them in the genus *Cirrinereis*.

Collected at Station 126: D-2 (East of Cedros Island, 38 fathoms); 126: D-3 (same locality, 40 fathoms) and 127: D-1 (same locality, 38 fathoms). Cat. Nos. 3,684, 3,692 and 36,637.

Family Sternaspidae.

Sternaspis Otto.

Sternaspis scutata Ranzani.

Thalessema scutata Ranzani, 1817, p. 183; pl. 11.
Sternaspis scutata Fauvel, 1927, pp. 216-218; fig. 76 a to g.

For earlier references see this paper.

Stimpson (1853, p. 29; fig. 19) described as *Sternaspis fossor* a species from Grand Manan and this has been supposed to be the only species of this genus found in northeastern North America. Moore (1910a, p. 144) stated that he was unable to distinguish the species found on the coast of southern New England from *S. scutata* Ranzani, but that this differs in a number of details from the species found further north which he listed as *S. fossor* Stimpson. Through the courtesy of Professor Moore I have had the opportunity of examining specimens from Newport, Rhode Island, which he labeled *scutata* and find that they agree in essential respects with Fauvel's description and with mine from Lower California. Fauvel considered that *S. fossor* is synonymous with *S. scutata* but specimens in my possession from Nova Scotia differ from these and agree with Moore's diagnosis (*loc. cit.*). It seems therefore that *fossor* should be retained, though it is possible that it may have a varietal rather than a specific value. The surface of the body is much more densely covered with papillae than in *scutata*, the shields are nearly square (taken together) rather than oblong, and the anterior setae are more slender and translucent.

Collected at Station 125: D-1 (East of Cedros Island, 44 fathoms), 126: D-2 (same locality, 38 fathoms) and 126: D-7 (same locality, 48 fathoms). Cat. Nos. 3,673, 3,684 and 36,649.

Family Maldanidae.

Maldane Grube.

Maldane carinata Moore.

Maldane carinata Moore, 1923, pp. 233-235.

Two specimens, neither entire, the pygidium being absent in both cases. Moore gave no figures but the specimens apparently conform to his diagnosis, except that he did not mention a second form of seta occurring in anterior somites. In addition to the very long, slender, narrowly limbate setae are others much shorter and fewer in number. These narrow abruptly and bend at nearly a right angle. Just at the bend the marginal wing is very prominent but soon disappears, leaving the long and slender terminal portion without the wing.

Collected at Station 125: D-1 (East of Cedros Island, 44 fathoms). 126: D-3 (same locality, 40 fathoms). Cat. Nos. 3,672 and 36,637.

Family Terebellidae.

Artacama Malmgren.

Artacama coniferi Moore.

Artacama coniferi Moore, 1905, pp. 853-855; pl. 44, figs. 11-13.

One specimen collected at Station 125: D-1 (East of Cedros Island, 44 fathoms). Cat. No. 3,672.

Lanice Malmgren.

Lanice heterobranchia (?) Johnson.

Lanice heterobranchia Johnson, 1901, p. 427; pl. 17, figs. 172-174.

The specimens were incomplete but correspond very well with Johnson's description except that the size differences between the gills are not so extreme as is there indicated.

Collected at Station 126: D-9 (East of Cedros Island, 56 fathoms) and Station 126: D-12 (same locality, 45 fathoms). Cat. Nos. 36,660 and 36,653.

Terebellides Sars.

Terebellides stroemi Sars.

Terebellides stroemi Sars, 1835, p. 48; pl. 13, figs. 31a-d.

Terebellides stroemi, McIntosh, 1922, pp. 209-215; pl. 120, fig. 3; pl. 127, figs. 5-5b.

The material is poorly preserved and identification was made by comparison with McIntosh's description.

Collected at Station 126: D-4 (East of Cedros Island, 40 fathoms), 136: D-4 (Arena Bank, 55 fathoms) and 147: D-2 (Santa Inez Bay, 60 fathoms). Cat. Nos. 36,335, 36,353 and 36,654.

Amphitrite O. F. Muller.

Amphitrite robusta Johnson.

Amphitrite robusta Johnson, 1901, pp. 425, 426; pl. 16, figs. 164-168.

A much mutilated specimen in which none of the recognisable details differs from Johnson's description but the preservation is too poor to allow of a reliable identification. In *Amphitrite* the gills are simple filaments. In these they have branches which would put the species in the genus *Neoamphitrite* of Hessle.

Collected at Station 126: D-4 (East of Cedros Island, 40 fathoms). Cat. No. 36,245.

Streblosoma Sars.

Streblosoma magna sp. nov.

(Plate II, Figures 26-28).

Some (apparently only a small portion), has been lost from the posterior end of the type. What remains is 80 mm. long. The prostomium is 3 mm. wide, the first somite 11 mm. and in the region of the tenth somite the body width is 14 mm. Thirty mm. back from the head the width is 11 mm. and behind this point the body abruptly narrows to 5 mm. There are fourteen ventral thoracic shields. The prostomium (Fig. 26) is a low dome whose width is about twice its length. Bounding the ventral face of the mouth is a thick pad partly covered by the lateral ends of the upper lip and posterior to this is a rounded lower lip whose lateral ends are more or less covered by the ventral tentacles which are the smallest of any. The tentacles form a dense mass and some of them are very long. There is no trace of eyes on the dorsal prostomial surface.

The first seta tufts appear on the second somite and occur on successive somites to beyond the fiftieth. In the thoracic region the tufts are prominent but posterior to the beginning of the narrowed portion of the body the setae are fewer in number and arise more directly from the body wall. Uncinigerous tori begin on the fourth somite. Throughout the

thoracic region the tori are long but in the narrowed body region they are much shorter and at the same time are more definitely elevated above the body surface.

There are three pairs of gills on somites 2, 3 and 4. The basal portion of each gill is a short, thickened, transverse ridge, those on opposite sides of the somite but belonging to the same pair separated from one another by a space a little shorter than the length of the ridge. These ridges are of essentially the same length in all gills. Along the upper surface of each ridge is a row of about twelve long branches which form a densely tangled mass reaching well beyond the prostomium.

An uncinus from the first torus (Fig. 27) has one large and two smaller teeth, the smaller ones situated one on either side of the base of the larger. This form of uncinus persists in the abdomen. Two kinds of setae occur in each seta tuft. The shorter ones are lance-shaped and have a narrow wing along the margins of the blade (Fig. 28). The longer ones are straight and narrow gradually to a very fine point. Their marginal wings are broader than in the shorter form and in some cases the wing seems to be broader on one side than on the other.

The type was collected at Station 136: D-12 (Arena Bank, 35 fathoms). It is Number 36,377 in the collections of the Department of Tropical Research of the New York Zoological Society.

Others were collected at Station 136: D-13 (Arena Bank, 45 fathoms). Cat. Nos. 36,377 and 36,382.

Family Capitellidae.

Dasybranchus Grube.

Fragments of two specimens probably of this genus were in the collection. One taken at Station 126: D-4 (East of Cedros Island, 40 fathoms), Cat. No. 36,245, seems to be *Dasybranchus caducus* Grube (Eisig, 1887, pp. 823-828; pl. 1, fig. 2). The other collected at Station 126: D-6 (same locality, 45 fathoms), Cat. No. 36,648, retained only the thoracic and a few abdominal somites and was too poorly preserved for accurate description.

Family Amphictenidae.

Pectinaria Lamarck.

Pectinaria brevicoma Johnson.

Pectinaria brevicoma Johnson, 1901, pp. 423-424; pl. 15, figs. 151-156.
Pectinaria brevicoma, Moore, 1923, pp. 216-217.

The identification is based on Johnson's diagnosis with additions made by Moore. Johnson figured the paleae as blunt-pointed but described them as either bluntly or acutely pointed. He said there are ten to twelve in each group; Moore says fourteen; mine have fifteen. In no other respect are they essentially unlike the diagnosis.

Collected at Station 125: D-1 (East of Cedros Island, 44 fathoms) and 126: D-1 (same locality, 38 fathoms). Cat. Nos. 3,672 and 36,648.

Family Serpulidae.

Apomatus Mörch.

Apomatus similis Marion & Bobretzky.

Apomatus similis Marion & Bobretzky, 1875, p. 97; pl. 12, fig. 25.

Fauvel (1914, pp. 359-361; pl. 31, figs. 44-46) described this species from localities ranging from the Azores to Norway and decided that it is

synonymous with *A. globifer* of Théel. Except that it is larger, the single specimen in this collection differs in no important respect from Fauvel's description. Théel thought that the presence of eyes on the branchia in *A. globifer* distinguished it from *similis* but Fauvel pointed out that this might be an age difference, being present in the young and absent in the adult, and also that there may be considerable variation in this respect. I distinctly saw one eye in my specimen, formed by six or seven refringent bodies. I cannot say if there were others.

Moore and Bush (1904, pp. 168-169; pl. 11, figs. 17, 18; pl. 12, fig. 38) described *Protula geniculata* from Japan, but Moore later (1908, p. 361) listed a specimen from the Gulf of Georgia in the north Pacific which retained the operculum, this having been lost in the type. This globular operculum places the species in the genus *Apomatus*. Moore (1923, p. 248) listed several specimens from Southern California. *A. similis* differs from *A. geniculata* in several respects. The branchiae of *geniculata* are recorded as having short bases concealed by the collar while in *similis* these are longer than the collar. *A. geniculata* has 18 radioles on a side while in *similis* the number is nearer 60. Moore does not mention the curved setae, limbate on the convex border, described by Fauvel, but his description of the other setae and the uncini agrees with the conditions in *similis*. The differences between the two are hardly to be explained as age differences and they are distinct species.

Collected at Station 136:D-24 (Arena Bank, 50 fathoms). Cat. No. 36,535.

Pomatostegus Schmarda.

Pomatostegus stellatus Abildgaard.

Terebella stellata Abildgaard, 1789, p. 142.
Pomatostegus stellatus, Mörch, 1863, p, 50.

A single specimen, identified by the aid of Ehlers' description (1887, pp. 296-300). The only disagreement is that while Ehlers describes the collar as forming a prominent triangular lobe on the ventral surface, in my specimen the margin is straight and the ventral portion of the collar is thrown into longitudinal pleats. Munro (1933, pp. 1081-1082), listed this species from the Panama region.

Collected at Station 136:D-30 (Arena Bank, 35 fathoms). Cat. No. 36,553.

A serpulid larger than *A. similis* was collected at Station 126: D-4 (East of Cedros Island, 40 fathoms), Cat. No. 36,666. The body is badly macerated and since it lacks the operculum its generic position is in doubt.

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EXPLANATION OF THE PLATES.

PLATE I.

Lepidonotus pilosus.

Fig. 1. Prostomium x 10.
Fig. 2. Parapodium x 7.5.
Fig. 3. Small papilla on elytron x 68.
Fig. 4. Hour-glass papilla x 45.
Fig. 5. Elytron x 25.
Fig. 6. Neuropodial seta x 85.
Fig. 7. Notopodial seta x 250.

Halosydna obtusa-cirrata.

Fig. 8. Prostomium x 15.
Fig. 9. Elytron x 12.
Fig. 10. Detail of elytron spines x 65.
Fig. 11. Parapodium x 12.
Fig. 11.5. Seta x 250.

Lepidasthenia ornata.

Fig. 12. Prostomium x 10.
Fig. 13. Seventh parapodium x 12.5.
Fig. 14. Seventy-fifth parapodium x 12.5.
Fig. 15. Seta x 250.

PLATE II.

Anaitides minuta.

Fig. 16. Prostomium x 7.5.
Fig. 17. Parapodium x 45.
Fig. 18. Seta x 250.

Nereis ambiguus.

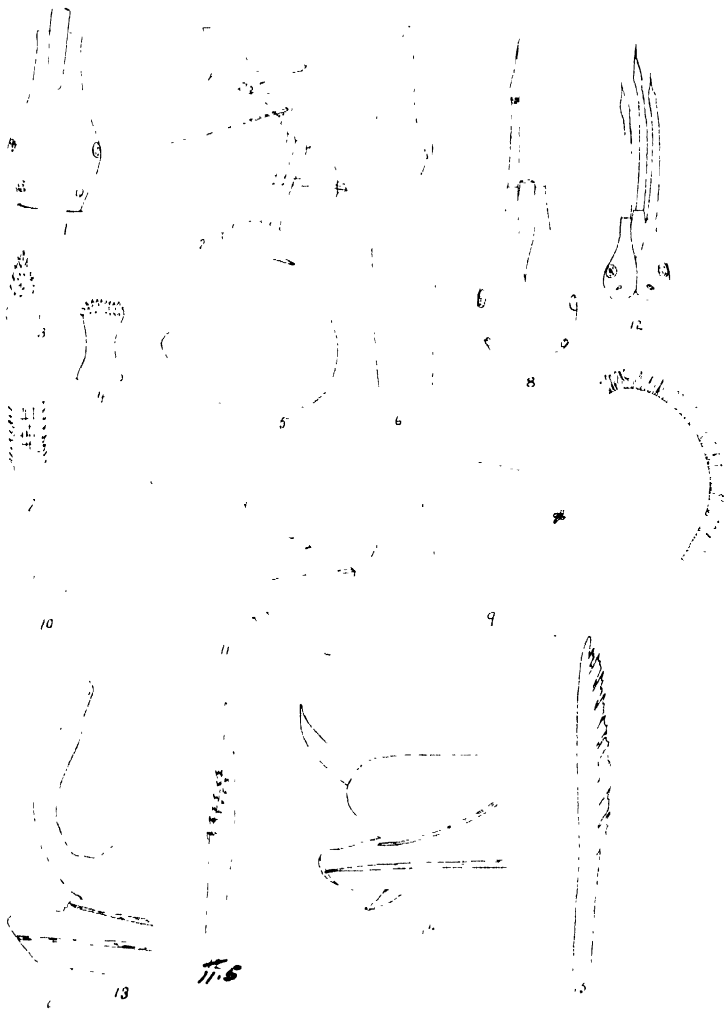
Fig. 19. Head x 12.
Fig. 20. Anterior parapodium x 35.
Fig. 21. Posterior parapodium x 30.
Fig. 22. Anterior notopodial seta x 250.
Fig. 23. Neuropodial seta x 250.
Fig. 24. Posterior seta x 250.

Cirratulus inhamatus.

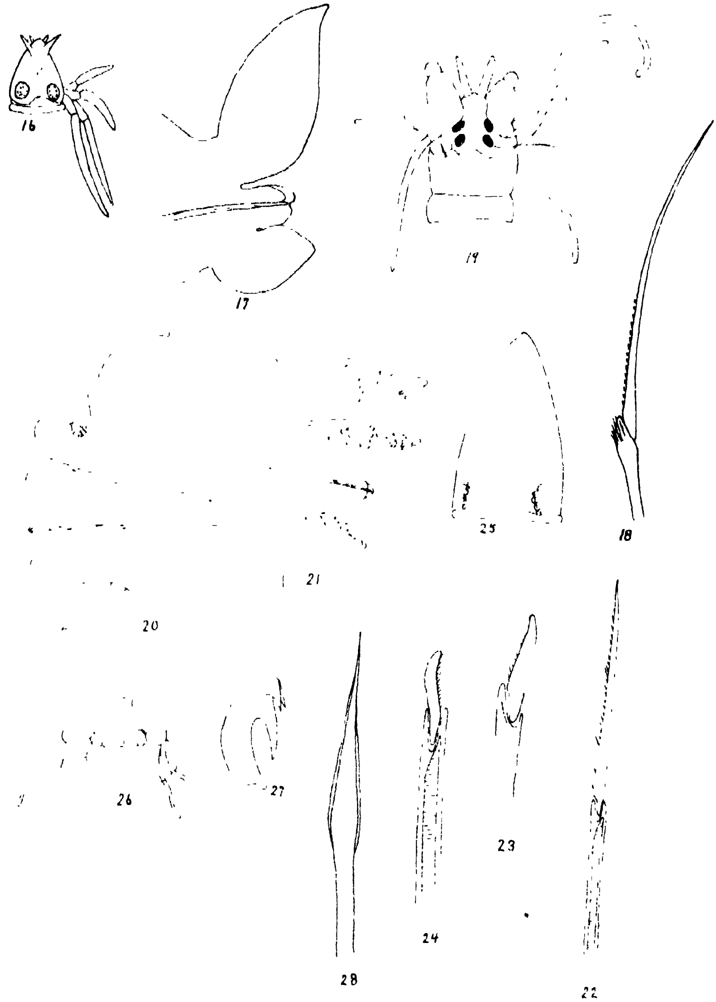
Fig. 25. Head x 5.

Streblosoma magna.

Fig. 26. Prostomium x 5.
Fig. 27. Uncinus from first torus x 250.
Fig. 28. Seta x 185.



POLYCHAETOUS ANNELIDS FROM THE WEST COAST OF LOWER CALIFORNIA, THE GULF OF CALIFORNIA AND CLARION ISLAND.



POLYCHAETOUS ANNELIDS FROM THE WEST COAST OF LOWER CALIFORNIA, THE GULF OF CALIFORNIA AND CLARION ISLAND.

10.

The Templeton Crocker Expedition. IX. Holothurians from the Gulf of California, the West Coast of Lower California and Clarion Island.[1]

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(Text-figures 1-3).

[Note: This is the ninth of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica,* No. 2, pp. 33 to 46.]

CONTENTS.

[1] Contribution No. 528, Department of Tropical Research, New York Zoological Society.

INTRODUCTION.

Although this collection of holothurians, collected around Lower California by the Templeton Crocker Expedition in 1936, comprises only 14 species, it represents nevertheless an important addition to our knowledge of these animals and their geographic distribution. Four new species are described from the tropical region and one from the more boreal waters off the west coast of Lower California; six species have had their area distribution extended from, respectively, Hawaii, Clipperton Island and Southern California, and only three were already known from the region explored.

Although some collecting of holothurians has been done at various times at various localities in Mexico, Lower California and Central America, very little has been known about their occurrence and generally speaking the holothurian fauna has always been considered poor. The reason for the meagre results of earlier collectors has undoubtedly been due to the somewhat peculiar ecological conditions which prevail in this region, namely, an exposed coast, frequently composed of either lava rocks, sand or mud flats, habitats which are well suited for only a few species. The dredgings of the *Zaca* reveal what one may have guessed—that a comparatively rich holothurian fauna exists in somewhat deeper water. More intensive dredgings at 20 to 150 fathoms' depth will probably double or triple the number of species already known and present valuable contributions to the study of the relationship of the holothurian fauna to those of the West Indian region and the western Pacific.

I beg the Director of the Expedition, Dr. William Beebe, to accept my sincere thanks for permitting me to study this interesting material.

The entire collection is deposited in the Museum of Comparative Zoology, Cambridge, Massachusetts.

ORDER ASPIDOCHIROTA.

Family Stichopodidae.

Genus **Parastichopus** Clark, 1922.

Parastichopus Clark, 1922, p. 47 (proposed in the text for the forms of *Stichopus* which are related to *S. tremulus, S. nigripunctatus*, etc.).

Diagnosis: Synallactid-like forms with cylindrical body. Mouth ventrally placed with broad tentacles, anus terminal. Dorsal side with large conical papillae and smaller feet; ventral side with cylindrical tube-feet more or less distinctly arranged in bands. Spicules, tables and either buttons or rods.

Type Species: *P. tremulus* (Gunnerus).

Remarks: There is no doubt that the two species known from the coast of California, *S. californicus* and *S. parvimensis*, should be removed from the typical tropical forms and it is proposed to extend the genus *Para-*

stichopus to include also these forms which are rather synallactid-like, particularly in their younger stages.

Parastichopus californicus (Stimpson).

Holothuria californicus Stimpson, 1857, p. 524 (84 in reprint).
Stichopus californicus, Clark, 1922, p. 70, pl. 1, figs. 8-12.
Stichopus johnsoni Théel, 1886, p. 4; Clark, 1922, p. 69, pl. 1, figs. 15-16.
Stichopus fuscus, Théel, 1886a, p. 5. Non *S. fuscus* Ludwig.

Diagnosis: Large form (50 cm.). Spicules, an external layer of large tables which decrease in size and complexity as the animal grows older, and an inner layer of large, smooth buttons with six to ten holes. Feet with endplate and large perforated plates; papillae with curved rods.

Type: Lost.

Type Locality: Tomales Bay, California.

General Range: From British Columbia to Cedros Island, west of Lower California. From tide-pools (northern localities) to about 50 to 100 fathoms (southern localities).

Local Distribution: Three specimens were taken east of Cedros Island (Station 126: D-1 and D-6) between 38 and 45 fathoms on muddy bottoms.

Remarks: The most southern locality hitherto known was off Santa Barbara, California. The *Zaca* specimens exhibit the typical reduction of the tables which is so characteristic of this species. The study of a large number of individuals shows that Clark was right in his assumption that *S. johnsoni* Théel from off Santa Barbara, 22 fathoms, is an immature stage of *S. californicus* (as is also Théel's "*S. fuscus*" from the same region).

The species is easily distinguished from *S. parvimensis* Clark, which occurs in the same region, from southern California to Point San Bartholomé, Lower California, but apparently only in shallow water. The latter seems always to have almost black tips on the papillae and its tables are much smaller (diameter of disk 0.04-0.05 mm., contrasted with 0.06-0.10 mm. in *S. californicus*).

Genus *Stichopus* Brandt, 1835.

Stichopus fuscus Ludwig.

Stichopus fuscus Ludwig, 1875, p. 22; 1898, p. 5, pl. 1, figs. 1-5; Clark, 1922, p. 45, (among non-identifiable forms).
Stichopus badionotus, Selenka, 1867, p. 316 (*partim*); Clark, 1922, p. 55, pl. 2, figs. 11-18 (*partim*).
Non *Stichopus fuscus*, Théel, 1886a, p. 5 (= *P. californicus* Stimpson).

Diagnosis: Large flattened form with thickened flanks, mouth ventral, anus terminal. Dorsal side with a varying number of blunt warts, ventral side with numerous feet in more or less crowded bands. Spicules, numerous small tables with round disk with a large number of marginal holes and a regular spire with flattened top with numerous small teeth. A varying number of C-shaped bodies are usually present. Feet with endplate and perforated supporting plates.

Type: Hamburg Museum.

Type Locality: "Patagonia." (Probably wrong, or an individual which accidentally has strayed so far south).

General Range: Gulf of California and southward to Ecuador, possibly reaching Patagonia. Shallow water, often exposed at low tide, to about 20 fathoms, or more.

Local Distribution: One adult was taken in 1 fathom near the shore of Santa Inez Bay, Gulf of California.

Remarks: This species is closely related to *S. badionotus* Selenka, a species which occurs widespread in the West Indies and Bermuda; Selenka's specimen from Acapulco, Mexico, refers undoubtedly to this species. The Pacific species seems always to be evenly brown or faintly mottled, while the West Indian form shows a diversity of variation in color. Comparison of well preserved specimens from both areas may show other, more important differences. The spicules have been found to be slightly larger in the Pacific form, viz., disk of tables 0.04-0.05 and 0.05-0.06 mm., C-shaped bodies 0.06 and 0.07 mm. in respectively *S. badionotus* and *S. fuscus*, according to Ludwig and Clark, and random samples taken by myself. (The spicules are slightly smaller in the ventral integument than in the dorsal as Ludwig already realized).

The species was described in 1875, from "Patagonia." Théel mentioned the species briefly in 1886 and identified in the same year (1886a) a specimen from off southern California as *S. fuscus*. Re-examination showed it was a young individual of *P. californicus*. In 1898 Ludwig revised the description of *S. fuscus*, figured the spicules of the type and mentioned that he had received two more specimens, one from Mazatlan, Mexico, and one from Machalilla, Ecuador. This reference was overlooked by Clark in his revision of 1922 and *S. fuscus* was therefore unjustly rejected.

Family Holothuriidae.

Genus *Holothuria* Linnaeus, 1758.

Holothuria difficilis Semper.

Holothuria difficilis Semper, 1867, p. 92, pl. 30, fig. 21; Panning, 1929, I, p. 136, text-fig. 20.

Holothuria frequentiamensis, Clark, 1902, p. 530; Panning, 1934, III, p. 73.

Diagnosis: Soft-skinned form with small, inconspicuous papillae on the dorsal side and numerous soft feet on the ventral side. Spicules, well-developed tables with eight to ten holes in the disk and regular spire with numerous small teeth; inner layer consists of oval, smooth buttons with mostly six holes. Feet with endplate and supporting plates.

Type: Possibly in Germany.

Type Locality: Samoa.

General Range: Widespread in the western tropical Pacific, common in Hawaii. The most eastern record hitherto was from Clipperton Island (*H. frequentiamensis* Clark). Never taken from the mainland of Mexico or of Central or South America. In tide-pools, often under rocks.

Local Distribution: Three specimens were taken in tide-pools on the shore of Sulphur Bay, Clarion Island.

Remarks: This species is closely related to *H. parvula* from the West Indies and, like the latter, it multiplies frequently through transversal fission. It differs, however, in that it reaches twice the size of *H. parvula* and is dark in color. Also the spicules present minor and apparently constant differences (see Deichmann, 1922, p. 206).

Holothuria inhabilis Selenka.

Holothuria inhabilis Selenka, 1867, p. 333, pl. 19, figs. 73-74; Panning, 1934, III, p. 79, text-fig. 62.

Holothuria maculata, Ludwig, 1894, p. 1. Non *H. maculata*, Brandt (*H. arenicola* auctores).

Diagnosis: Large holothurian (up to 20 cm. or more) with small tentacles, about 20 in number; mouth ventral, anus terminal; dorsally papillae, ventrally small feet. Skin filled with an abundance of spicules, thin and tough in younger individuals, thicker in larger ones. Calcareous ring low; a single Polian vesicle and a single stonecanal embedded in the dorsal mesentery but with the head free to the right. Spicules, tables with smooth to knobbed edge, frequently reduced; spire low with numerous teeth. Buttons crowded, mostly regular with six to ten holes, and varying from strongly knobbed to almost smooth. Feet with small endplate and numerous supporting plates with a varying number of holes along the sides and in the ends. Dorsal papillae often with trace of endplate and mostly curved supporting rods.

Type: M. C. Z.

Type Locality: Hawaii.

General Range: Hawaii, Cocos Island, Lower California, and Clarion Island. At about 50 fathoms depth.

Local Distribution: Three specimens were taken from Arena Bank (Station 136: D-26) off Clarion Island (Station 163: D-4) and from Santa Inez Bay, between 45 and 50 fathoms; on sandy bottoms.

Remarks: The three specimens vary much in size and color, no one of them being satisfactory as the basis for a description. The dorsal warts are very differently pronounced; as to color, it varies through different shades of brown. The spicules agree well with those of the type and show similar changes; they are apt to be somewhat less knobbed in the older specimens, also the smaller buttons become gradually more dominating.

The type specimens were up to now the only specimens described but re-examination of Ludwig's specimens of supposedly *H. maculata* Brandt (now commonly accepted as *H. arenicola* Semper) from Cocos Island, 66 fathoms, (1894), showed that they are *H. inhabilis*. Ludwig had evidently been mislead by some of the smoother buttons. His specimens of *H. maculata* from shallow water near Panama (1875) are correctly identified, as may be inferred from his description of the inner anatomy.

Holothuria lubrica Selenka.

Holothuria lubrica Selenka, 1867, p. 329, pl. 18, fig. 59; Panning, 1934, II, p. 45, text-fig. 38.

Diagnosis: Soft-skinned form with large tentacles, dorsally small papillae, ventrally large soft feet. Spicules, scattered curved rods with spines; feet with large endplate and a few curved rods sometimes with marginal holes. Stonecanal with long, spirally furrowed head; sometimes more than one canal is present.

Type: Probably in Germany.

Type Locality: Acapulco, Mexico.

General Range: West coast of Central America and Mexico, Lower California. According to various authors also reported from the East Indies, but possibly a case of wrong identification as a number of related forms are known. (See Panning, p. 45). Shallow water, mostly hidden under rocks.

Local Distribution: Four specimens were taken in tide-pools on Little Inez Island, Santa Inez Bay, Gulf of California.

Remarks: The color is dull slate-gray with black tentacles and often two rows of black spots on the dorsal side; the ventral feet have yellow tips.

Like the related form *H. glaberrima*, from the West Indies, this species seems eminently fitted to withstand the effect of the surf. It clings tenaciously to rocks and is very difficult to wrench off without damaging the tube-feet.

Holothuria paraprinceps sp. nov.

(Text-figure 1, 1-10).

Diagnosis: Stout form (probably up to 25 cm. or more) with ventral mouth and terminal anus. Dorsal side with small conical papilla; ventral side with comparatively small feet often completely retracted. Skin rigid with spicules, probably relatively thin but tough in the expanded specimen. Calcareous ring tall, with distinct, low, blunt, posterior projections on the radials. Spicules small; tables (disk 0.04-0.08 mm.) with knobbed edge (knobs often bent upward) and frequently spire reduced to four knobs. In the papillae a number of huge tables (height 0.3 mm.) with pointed conical spire. Numerous buttons (0.05-0.09 mm. long), often incomplete, mostly with six holes and varying from almost smooth to knobbed. Ventral feet with small endplate and numerous large, smooth supporting rods or plates with perforations along the sides and in the ends. Dorsal papillae with no endplate or a vestige and curved rods. Color almost black with a whitish ring around the base of the papillae.

Type: Cat. No. 1807 (M. C. Z.).

Type Locality: Arena Bank, Gulf of California, 35 fathoms.

General Range: Known from the type locality and also off Panama (mentioned by Deichmann, 1930, p. 59, without name attached). From 35 fathoms.

Local Distribution: One specimen, the holotype, was taken on Arena Bank (Station 136: D-30) at a depth of 35 fathoms on a sandy bottom.

Remarks: The specimen examined must have measured 20 to 25 cm. in expanded condition. It was cut open and the inner organs removed so that very little can be said about its anatomy. Probably it resembles that of *H. princeps* Selenka. Aside from the difference in color, the spicules are much more smooth and regular in *H. paraprinceps* than in Selenka's species, although most likely they have developed from the same stock.

In the West Pacific there are two other species in which large, tack-like tables have been described. One is *H. spinifera* Théel (1886, p. 176, pl. 8, fig. 1) from the Philippines, 18 fathoms; also Ceylon, Pearson, 1913; (see Panning). It differs from *H. paraprinceps* in the lighter color and in its lack of posterior prolongations on the calcareous ring (possibly merely that Théel did not consider the protuberances worthy of that name). Direct comparison of the spicules is necessary in order to decide whether the two species are identical. The other form is *H. fusco-olivacea* Fisher (1907, p. 672, pl. 89, figs. 3, 3a, pl. 70, fig. 3). Its tack-like tables are much smaller (0.12 mm.) and besides it has some peculiar, spiny, warted buttons, which are entirely unlike those found in *H. paraprinceps*.

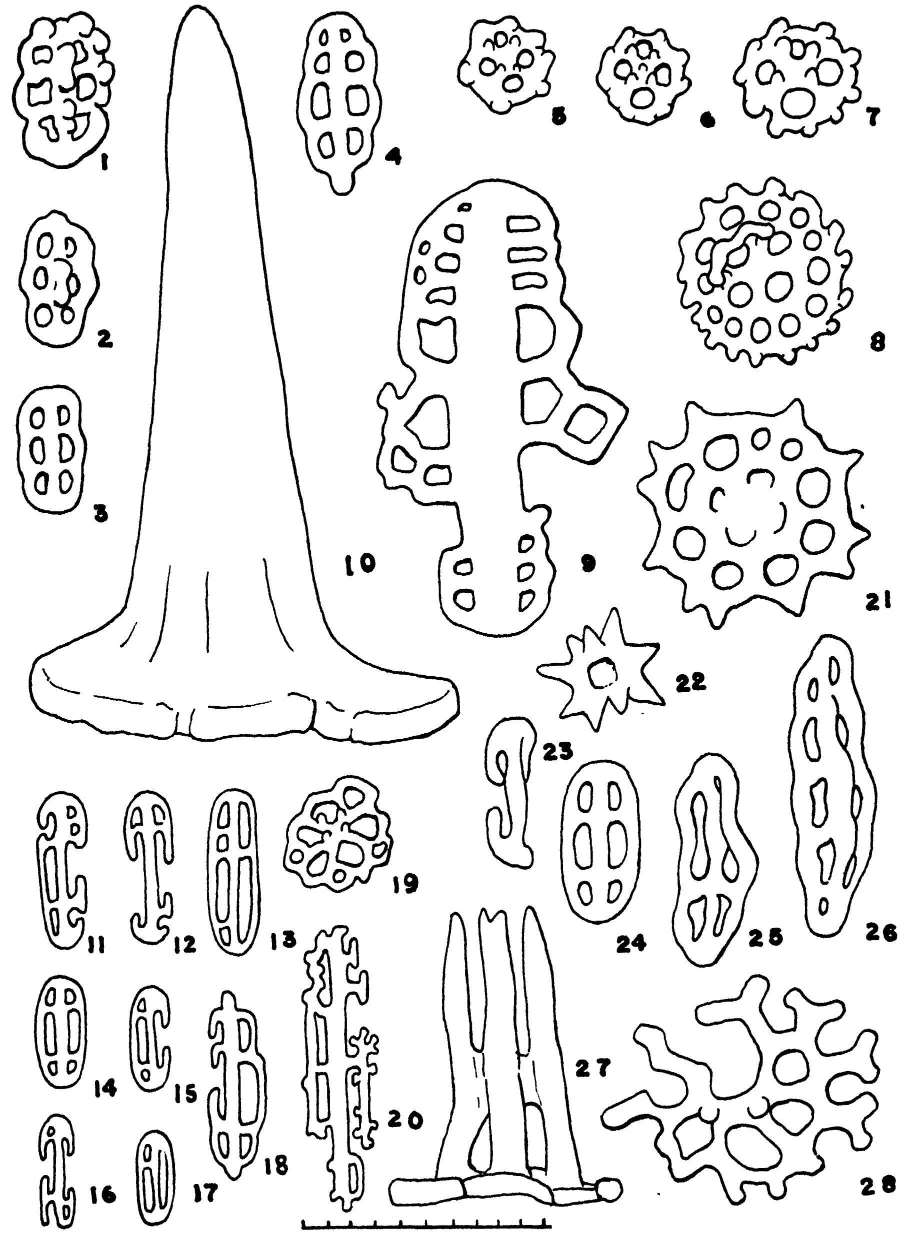
Holothuria pluricuriosa sp. nov.

(Text-figure 1, 11-20).

Diagnosis: Stout form with blunt ends, mouth terminal, anus terminal, skin smooth, slippery; dorsally numerous papillae, many on low warts; ventrally numerous papilliform feet, completely retractile. Calcareous ring of typical shape, one ventral Polian vesicle and a tuft of free stonecanals on the right side of the dorsal mesenterium. Spicules, small tables with smooth disk (0.05 mm.) and low spire, often reduced; numerous smooth oblong buttons (0.04-0.015 mm.) with narrow, slit-like holes, mostly two to six in number, often twisted or incomplete. No endplate seems to be present in the ventral feet; a few straight or curved rods or plates resembling irregular buttons are found in both the dorsal and ventral appendages.

Type: Cat. No. 1808 (M. C. Z.).

Type Locality: Santa Inez Bay, Gulf of California.



Text-figure 1.
Scale 1/100 mm.

Holothuria paraprinceps sp. nov. **1-4**, various types of buttons; **5-8**, various tables; **9**, supporting plate from tube-foot; **10**, large table from papilla.

Holothuria pluricuriosa sp. nov. **11-18**, buttons; **19** table; **20**, supporting plate from tube-foot.

Holothuria zacae sp. nov. **21**, table; **22**, tip of spire from same; **23-26**, buttons; **27**, large table from papilla; **28**, incomplete disk of table.

General Range: Known only from the type locality, at few fathoms' depth, possibly also between tide marks.

Local Distribution: A single specimen, the holotype, was taken in Santa Inez Bay (Station 141: D-1) between 7 and 9 fathoms, on a bottom composed of sand and finely crushed shell.

Remarks: The specimen is strongly contracted and measures only 7 cm.; expanded it would probably be twice as long. Color in life plain light brown.

The species seems superficially most closely related to *H. curiosa* Ludwig from the East Indies, but differs in its color and the presence of numerous stonecanals. The relationship of all the forms with reduced tables and incomplete twisted buttons needs, however, re-investigation. Panning has placed *H. fuscorubra* Théel as a variety of *H. curiosa* and as the former is reported from both the Hawaiian Islands and the Galápagos Islands (Clark, 1902, p. 527), it might be thought that the present species is *H. fuscorubra*. Comparison of Clark's specimen shows pronounced differences in the spicules, viz., spinous rim on the tables, shorter, more regular buttons and huge, bilaterally symetrical plates in the ventral feet which, moreover, have large endplates. If Panning's assumption is correct, that *H. curiosa* is closely related to *H. fuscorubra*, then the present species is not particularly related to the former species.

Holothuria zacae sp. nov.

(Text-figure 1, 21-28).

Diagnosis: Stout, smooth-skinned form with about 20 small tentacles; dorsal and ventral side with numerous retractile papillae, on the ventrum often completely retracted into pits. Spicules, scattered tables of two types, viz., smaller with regular disk (0.08-0.09 mm.) with pointed marginal teeth and tapering spire ending in few pointed teeth, and larger tables with irregular disk, often incomplete, and tall spire (0.12 mm.) composed of often more than four pillars which end as blunt or pointed rods. Buttons (0.08-0.09 mm.) thinly scattered, smooth, often twisted or incomplete, mostly with six holes. Apparently no endplate; appendages supported by larger buttons and curved rods with a varying number of holes along the sides and in the ends. Color, mottled with dark appendages and two rows of dark spots on the dorsal side.

Description: The type, which is strongly retracted, measures about 18 cm. The small tentacles are completely retracted, hidden by the strong, oral sphincter; only 19 were counted. It was not possible to decide the exact position of the mouth; the anus was terminal. The color is very striking: Dorsally two rows of large, irregular, dark spots; the individual appendages dorsal and ventral, are dark brown, surrounded by a pale ring at the base and the remaining part of the skin between them is light brown, on the ventrum almost white. The calcareous ring is low; all other organs were removed, so nothing can be said about the inner anatomy.

Type: Cat. No. 1809 (M. C. Z.).

Type Locality: Santa Inez Bay, Gulf of California.

General Range: Known only from the type locality. From 60 fathoms.

Local Distribution: A single specimen, the holotype, was taken from Santa Inez Bay (Station 147: D-2), from a depth of 60 fathoms on a muddy bottom.

Remarks: It is remarkable that so large and strikingly colored a species apparently has never been described before. There is, of course, the possibility that it has been disguised under another name and an insufficient description. No species which resembles it is known from the West Indies, and from Hawaii the only form which has somewhat similar spicules is *H. hawaiiensis* Fisher, and that species has 30 tentacles and also distinct endplates in the feet.

ORDER DENDROCHIROTA.

Family Cucumariidae.

Genus *Cucumaria* Blainville, 1834.

Cucumaria piperata (Stimpson).

Pentacta piperata Stimpson, 1864, p. 161.
Cucumaria piperata, Clark, 1924, p. 56.

Diagnosis: Smooth-skinned form with large soft feet restricted to the ambulacra. Tentacles of equal size. Calcareous ring low. Spicules, knobbed, perforated plates with dentate handle and small, four-holed, swollen or knobbed buttons; in feet a rudimentary endplate and three-armed supporting rods. Spicules reduced in older individuals. Color white with minute brown spots.

Type: Lost.

Type Locality: Puget Sound, Washington.

General Range: From Puget Sound as far south as Lower California. In the northern localities, in tidepools or at a few fathoms; farther south in deeper water, 45 fathoms.

Local Distribution: One small specimen was taken off San José Point, west of Lower California (Station 175: D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: Pacific Grove, California, has hitherto been regarded as the most southern locality where this species occurred, so the finding of it farther south is of interest. The pepper-like spots have disappeared in the present specimen, probably due to the effect of the formalin in which the animal was preserved; a note in the jar, however, indicates that the animal was spotted.

Cucumaria lissoplaca Clark.

Cucumaria lissoplaca Clark, 1924, p. 55.

Diagnosis: Small form (3 cm.) with cylindrical feet in double rows along the ambulacra. Calcareous ring with long posterior prolongations. Spicules crowded, forming an external layer of minute, delicate tables which in most cases are destroyed, and an inner layer of smooth, perforated plates mostly lozenge-shaped with four central holes and a small hole in each end. Feet with endplate and curved supporting tables often with the two-pillared spire reduced.

Type: Victoria Memorial Museum, Ottawa, Canada.

Type Locality: Queen Charlotte Sound, British Columbia.

General Range: South coast of Alaska (records unpublished) and as far south as Cedros Island, west of Lower California. Tidepools in the north to about 50 fathoms in the south.

Local Distribution: A single specimen was taken east of Cedros Island (Station 126: D-2) at a depth of 38 fathoms on a muddy bottom.

Remarks: Examination of a large number of specimens in various collections tends to show that this species has its main distribution from Alaska to Monterey Bay and the *Zaca* specimen represents the first record south of that region.

Normally this species is pure white, but the *Zaca* specimen is encrusted with a rusty brown sediment. No trace was found of the external, fragile tables, but since the specimen was preserved in formalin it was almost inevitable that they would be destroyed. These tables were not found in

the types, but in other (smaller) specimens, collected in the Puget Sound region and in Monterey Bay.

Cucumaria populifera (Stimpson).

Pentacta populifera Stimpson, 1857, p. 161.

Cucumaria populifera, Clark, 1901, p. 171; 1924, p. 55; Bush, 1921, p. 76, text-figs. 40-41.

Cucumaria tenuicoriata, Wells, 1924, p. 121, pl. 3, fig. 4, text-fig. 4.

Diagnosis: Small form (5-6 cm.) usually fusiform body. Feet slender, restricted to the ambulacra forming narrow bands. Skin thin, flexible, filled with spicules. Calcareous ring with long posterior prolongations. Spicules, large tables with roundish to star-shaped disk with numerous holes and stout spire with numerous teeth; a varying number of smooth, perforated plates; feet with small endplate and numerous curved supporting tables with low two-pillared spire.

Type: Lost.

Type Locality: Puget Sound.

General Range: From Puget Sound to Cedros Island, west coast of Lower California. From a few to about 60 fathoms.

Local Distribution: A single specimen was taken east of Cedros Island (Station 126: D-9) at a depth of 56 fathoms on a muddy bottom.

Remarks: Hitherto the most southern locality for this species was Monterey Bay. Cedros Island represents probably the southern limit for this characteristic species. The *Zaca* specimen is one of the largest which has ever been taken.

Genus *Thyone* Oken, 1815.

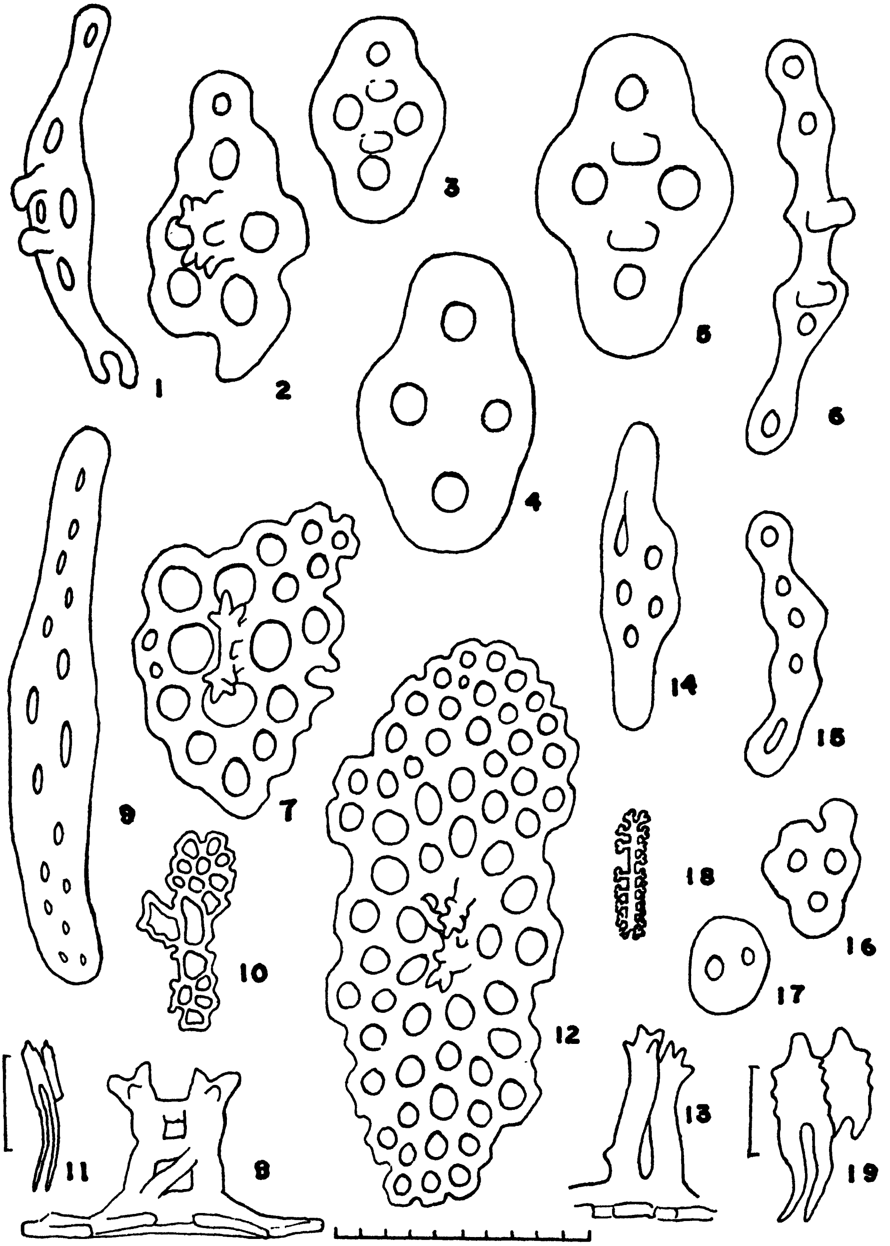
Thyone benti sp. nov.

(Text-figure 2, 1-11).

Diagnosis: Large form (11 cm.) with numerous, comparatively slender tube-feet scattered over the body, often indistinctly arranged in bands along the ambulacra. Tentacles surprisingly small, the two ventral ones smaller. Calcareous ring tall, narrow, with extremely long tails on the radials and narrow interradials. Spicules, four-holed oval tables with two-pillared spire; feet with curved supporting tables and endplate; introvert with two-pillared tables with numerous holes, tentacles with oblong, thick rods with few small holes and delicate, reticulated plates. Spicules apt to become reduced to buttons and rods.

Description: Externally the species resembles *T. briareus* Lesueur, but the feet are fewer. The color is pale brown, in the *Zaca* specimen small dots of pigment are scattered over the body. The type specimen measures about 5 cm. in length (strongly contorted, partly bloated), a specimen from off southern California measures about 7 cm., and the *Zaca* specimen, which lacks the oral end and most inner organs, is about 11 cm. long.

Internally the calcareous ring offers the most conspicuous feature. In the type it measures 1.5 cm. in height (including the tails), in the specimen from off southern California, 2 cm. The radials are deeply cleft and have very long narrow tails; the interradials are also narrow and tall. There is a single Polian vesicle, a single stonecanal attached in the dorsal mesentery; the third loop of the intestine is attached by a mesentery which runs in the ventral interambulacrum and, in its latter part, is attached to the midventral ambulacrum. The respiratory trees are (in the *Zaca* specimen) attached to the lateral interambulacra and each has a large, ventral branch; the



Text-figure 2.

Large magnification, scale 1/100 mm., except 11 and 19, scale 1 cm.

Thyone benti sp. nov. **1-3**, supporting table and reduced tables from the type; **4-6**, reduced tables and supporting table from the *Zaca* specimen; **7-8**, tables from introvert; **9-10**, rod and perforated plate from tentacles, all from type; **11**, radial and interradial piece of calcareous ring, type.

Thyone glasselli Deichmann. **12-13**, table from introvert; **14-17**, supporting rods and buttons; **18**, rosette from tentacle; **19**, radial and interradial piece from calcareous ring, all from type.

gonads form in all specimens two tufts of numerous fine tubes attached in the dorsal mid-line, almost equidistant from oral and anal end, possibly closer to the anal end.

The spicules are not crowded and undergo considerable modifications; possibly they may disappear completely. Typically they consist of oval tables with four holes and two-pillared spire, and the supporting tables in the feet are derived from the same type which has become elongate and usually has a small perforation in each end. The endplate seems always to be well developed. In the type these spicules dominate, although reduced button-like tables and rod-like supporting plates may occur. In the *Zaca* specimen, however, most spicules have changed to the button and rod-like stage, and in the specimen from Southern California they are extremely reduced.

Type: Cat. No. 1810 (M. C. Z.).

Type Locality: Puget Sound (H. L. Clark coll.).

General Range: From Puget Sound, to west coast of Lower California; about 40-60 fathoms.

Local Distribution: A single specimen was taken east of Cedros Island (Station 127: D-1) by the *Zaca* at a depth of 38 fathoms on a muddy bottom. (M. C. Z., Cat. No. 1812). Only two other specimens are known, viz., the type from Puget Sound (M. C. Z.), and a specimen from off Southern California (U. S. N. M.).

Remarks: It lies near to question the affinities of the present species with *T. glasselli* Deichmann (Text-figure 2, 12-19) recently (1936, p. 63) described from the Gulf of California. Although the latter species undoubtedly has similar tables when it is young, it cannot possibly be confused with *T. benti* as comparison of the calcareous ring and the spicules in the introvert shows. It is, comparatively speaking, a much more robust form with a crown of large tentacles, with broad radials and interradials and relatively short tails on the calcareous ring. The introvert has much larger and more elaborate tables and the tentacles contain typical rosettes but not heavy, perforated rods, nor delicate reticulated plates.

Family Psolidae.

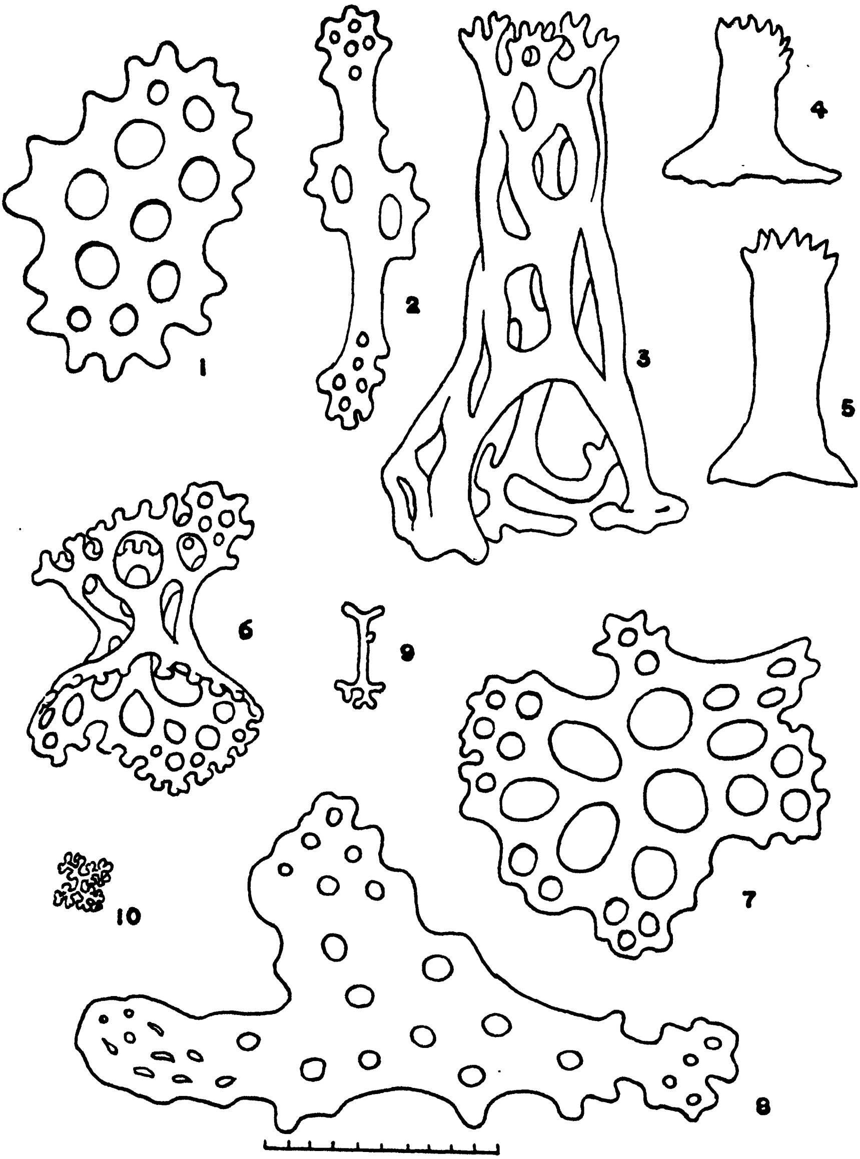
Genus *Thyonepsolus* Clark, 1901.

Thyonepsolus beebei sp. nov.

(Text-figure 3, 1-10).

?*Thyonepsolus nutriens* Clark, 1923, p. 161. Non *T. nutriens* Clark, 1901.

Diagnosis: Small form (few cm.) with distinct sole with three crowded bands of feet; dorsal side with numerous feet and covered completely by comparatively large scales and with a well developed layer of external spicules. Spicules in sole perforated plates (0.14-0.17 mm.) with dentate edge; feet with large endplate and oblong, perforated supporting rods (0.14-0.18 mm.). Dorsal side with large, heavy scales and a layer of irregular perforated plates (0.17-0.30 mm.) slightly hollow, smooth, often with four large central holes and a number of smaller holes in the margin; plates sometimes cross or star-shaped. Besides, a large number of tall, tower-like deposits (0.25-0.30 mm.) with more or less flaring edge and a spire composed of coalescent stems ending in more or less distinct teeth, and small (0.1 mm.), delicate, hourglass-shaped bodies with lace-like perforations; feet with small but distinct endplate and oblong, perforated rods. Tentacles with heavy, thick plates and rods with few, small holes; branches with minute rods and rosettes.



Text-figure 3.

Large magnification except 4-5; scales 1/100 mm. and 1/10 mm.

Thyonepsolus beebei sp. nov. **1**, plate from sole; **2**, supporting rod from ventral tube foot; **3**, young tower from dorsal side; **4-5**, outline of complete towers (low magnification); **6**, hourglass-shaped body; **7**, perforated plate from dorsal side; **8**, plate from tentacles; **9-10**, rod and rosette from tentacle.

Type: Cat. No. 1811 (M. C. Z.).

Type Locality: Off Arena Bank, Gulf of California.

General Range: At present known only from the type locality but very likely Clark's record of *T. nutriens* from "Lower California" refers to this

species. Likewise Verrill's imperfectly described *Lissothuria ornata* (1867) from Panama may quite well be this species. From shallow water (2.5 fathoms).

Local Distribution: A single specimen, the holotype, was taken off Arena Bank (Station 136: D-33) at a depth of 2.5 fathoms in coral (*Pocillopora ligulata*).

Remarks: Superficially this species resembles *T. nutriens* Clark from the coast of California, and has the same red color. Actually it is more closely related to *T. brasiliensis* (Théel) from the West Indies. Unfortunately neither the material of *T. brasiliensis* (Théel's two types and a number of young individuals from Tobago), nor the single specimen of *T. beebei* (originally preserved in formalin) are well suited for comparison, and the apparent external dissimilarities between the two forms are probably purely accidental. An analysis of the spicules shows that *T. beebei* has more distinct marginal teeth on the plates in the sole, the dorsal plates are larger and more reticulated, the tower-like deposits have frequently a broad base and the hourglass-shaped bodies are more complete with numerous perforations, than is the case in *T. brasiliensis* (see Deichmann, 1930, pl. 21, figs. 1-6). The spicules in the tentacles are of exactly the same size and type in both forms.

The chief differences between the three species are briefly summarized as follows:

1. Dorsal scalecovering incomplete in the midline (in adult specimens). Scales numerous and small; external layer of perforated plates crowded. Tentacles lacking rosettes and delicate rods but with numerous four-holed buttons.

   T. nutriens Clark
   (Coast of California).

1. Dorsal scalecovering complete in the midline; scales few (7-10) between oral and anal scales, and large. Tentacles with rosettes and delicate rods. 2.

2. Plates in sole with almost smooth margin; dorsal plates mostly small, incomplete, with few holes; tower-like bodies with small base.

   T. brasiliensis (Théel)
   (West Indies).

2. Plates in sole with strongly indented margin; dorsal plates large with numerous holes; tower-like bodies with broad base.

   T. beebei sp. nov.
   (Gulf of California).

Order Molpadonia.

Family Molpadiidae.

Genus *Molpadia* Cuvier, 1817.

Molpadia intermedia (Ludwig).

Trochostoma intermedia Ludwig, 1894, p. 161, pl. 16, figs. 7-21.
Molpadia intermedia, Clark, 1908, p. 162, pl. 12, figs. 5-15.

Diagnosis: *Molpadia* with small tables with three-pillared spire; same type in tail region but with two marginal prolongations from the disk. Anchors and raquet-shaped bodies present in young individuals. Spicules almost completely reduced in adult, except in tail region. Numerous phosphatic bodies.

Type: U. S. N. M.

Type Locality: Off Central America.

General Range: From Alaska to off the west coast of South America. From about 30 to 200 fathoms. (Records from deeper water possibly indicate another species).

Local Distribution: Three specimens were taken east of Cedros Island (Station 126: D-5) at a depth of 43 fathoms on a muddy bottom.

Remarks: One of the most common species off the west coast of North and South America in muddy localities.

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11.

Notes on the Cestodes of North American Sparrows[1].

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INTRODUCTION.

Five species of cestode parasites have been recorded from the sparrow, *Passer domesticus* Linnaeus, in various localities of Europe, central Asia, and India. Two of these species have been reported from the sparrow in North America. Linton (1927) found *Paricterotaenia parina* (Duj., 1845) Fuhrmann, 1932, in sparrows collected in the vicinity of Woods Hole, Massachusetts, and Hopkins and Wheaton (1935) found *Choanotaenia passerina* (Fuhrmann, 1907) Fuhrmann, 1932, in sparrows taken at Champaign-Urbana and St. Joseph, Illinois.

During the summer of 1936, dissection of specimens of *P. domesticus*, 28 from the region of Birmingham and 26 from Huntsville, Alabama, yielded 54 cestodes. Of this number, only 23 were in condition to be mounted. All of them were found to belong to the same species. The incidence of infection of the sparrows of the Birmingham region was 28.5%, and of those from Huntsville, 15.3%. The cestodes correspond in morphology to the description given by Johnston (1909) for *Monopylidium passerinum* Fuhrmann, 1907. The following account brings together the pertinent literature concerning *P. parina* and *C. passerina* in North America, indicates that *C. passerina* is probably widely distributed among the sparrows of this continent, and provides additional evidence to support the suggestion that the specimens from *P. domesticus* in North America belong to a single species.

HISTORICAL REVIEW.

There has been much confusion in the literature concerning the genera *Choanotaenia* Railliet, 1896, *Monopylidium* Fuhrmann, 1899, and *Choanotaenia* Fuhrmann, 1908. Railliet (1896) erected the genus *Choanotaenia* and designated *C. infundibulum* Bloch, 1779 (=*T. infundibuliformis* Goeze, 1782) as type species. Fuhrmann (1899) erected *Monopylidium* to contain *Taenia crateriformis* Goeze and *Davainea musculosa* Fuhrmann, 1896. Braun (1900) designated *M. musculosum* as type of the genus. Clerc (1903) recognized *Choanotaenia* and *Monopylidium* as distinct genera. Fuhrmann (1907), in his revision of the classification of cestodes given by Braun (1894-1900), differentiated between the subfamilies Dilepininae Fuhrmann and Dipylidinae Railliet, on the basis of morphological variations of the uterus in the two groups. He referred *Choanotaenia* to the former subfamily, and *Monopylidium* to the latter one. In the same account Fuhrmann recognized the family Hymenolepinidae as distinct from Dilepinidae. Both Clerc (1903) and Fuhr-

[1] Contribution from the Biological Laboratory, New York University, University Heights.

mann (1907) placed *C. infundibulum*, type species of *Choanotaenia*, in *Monopylidium*. To replace *C. infundibulum* as type of *Choanotaenia*, Fuhrmann (1908) designated *C. galbulae* as type species of this genus. Railliet and Henry (1909) noted that removal of the type species of *Choanotaenia* to *Monopylidium* constituted a violation of the International Code of Zoological Nomenclature. Furthermore, Ransom (1909) stated that: "*Monopylidium* must fall into synonymy if *C. infundibuliformis* (type of *Choanotaenia*) is made congeneric with *Monopylidium musculosum* (type of *Monopylidium*), *Choanotaenia* (1893) being of date prior to that of *Monopylidium* (1899). If, as Clerc and Fuhrmann believe, *C. infundibuliformis* and *M. musculosum* should go into the same genus, that genus must be known as *Choanotaenia*, not as *Monopylidium*. Such action would leave the genus *Choanotaenia* Fuhrmann, 1908 (not Railliet) without a name, and it would become necessary to rename the genus." To supplant the preoccupied name *Choanotaenia* of Fuhrmann, Railliet and Henry (1909) erected the genus *Icterotaenia*, and designated *I. galbulae* as type species.

Ransom (1909), from his observations upon *C. infundibulum*, concluded that any breaking down of the uterus as described by Clerc (1903) must be regarded as dubious. He stated further that his interpretation agreed with that of Cohn (1901), who also found the uterus persistent and possessing an "irregularly lobulated cavity incompletely subdivided by infoldings from the wall." Upon the basis of these observations, Ransom pointed out that: "If this is true, and if no further development of the egg capsules occurs, *Choanotaenia infundibuliformis* differs from *Monopylidium*, in which the uterus is said to break down into egg capsules, and it is therefore possible to recognize both *Choanotaenia* and *Monopylidium*, changing but slightly Fuhrmann's arrangement of species, namely removing *Choanotaenia infundibuliformis* from *Monopylidium* to *Choanotaenia*, where it belongs. I have not considered the differences between *Monopylidium* and such genera as *Choanotaenia*, and *Anomotaenia*, sufficiently marked to warrant placing them in different subfamilies, as Fuhrmann has done. *Monopylidium*, in spite of the breaking down of the uterus, seems to me much more closely related to the genera named than to *Dipylidium*, with which Fuhrmann has united it in a subfamily separate from the others." Ransom placed the controversial genera, and the remaining members of the subfamily Dilepininae Fuhrmann, in the subfamily Dipylidiinae Stiles, 1896, of the family Hymenolepididae Railliet and Henry, 1909, and the family "Dilepinidae" Fuhrmann, 1907, disappeared. He concluded also that *Choanotaenia* Railliet, 1896, should include certain species previously referred to *Monopylidium* Fuhrmann, 1899, and *Icterotaenia* Railliet and Henry, 1909; these genera were considered "in part" as synonyms of *Choanotaenia* Railliet, 1896.

For the invalidated *Choanotaenia* of Fuhrmann, Lühe (1910) erected the genus *Parachoanotaenia* and, among others, included in it the species *P. porosa* (Rud., 1810), but failed to designate any species as type. He recognized the genus *Choanotaenia* Railliet, Lhe. em., with species *P. Marchali* and *P. cingulifera*, and the genus *Monopylidium* Fuhrmann e.p., Lhe. em., with *M. macracanthum* Fuhrmann as sole member. These genera were placed in the family Dilepididae Fuhrmann e.p., Lhe. em. He made no mention, however, of the genus *Icterotaenia* and its type species, *I. galbulae*, or *Choanotaenia parina* Duj., which had been referred to the genus *Icterotaenia* by Railliet and Henry (1909). *Parachoanotaenia*, without a specified type, is clearly a synonym of *Icterotaenia*, and was suppressed by Fuhrmann (1932).

According to Fuhrmann (1932), the investigations of Skrjabin and Cohn on *I. galbulae*, type species of its genus, have shown that it belongs in the genus *Anomotaenia*. *Icterotaenia* thus became invalid as a generic name, and was replaced (Fuhrmann, 1932) by the genus *Paricterotaenia*, with *P. porosa* designated as type species. Furthermore, he recognized *Monopylidium* as a synonym of *Choanotaenia* Railliet, 1896. The latter, having priority, was retained as a member of the subfamily Dipylidiinae Stiles, 1896.

There is still uncertainty concerning the systematic positions of certain of the previously mentioned species. Ransom (1909) and Sprehn (1932) placed *Paricterotaenia parina* (Duj., 1845) Fuhrmann, 1932, in the genus *Choanotaenia* Railliet. Fuhrmann (1932) defined this species as a member of *Paricterotaenia* on the basis of the sacciform uterus typical of this and related species. Furthermore, the position of *C. musculosum* is dubious and information regarding this species is incomplete, as is indicated by the following statement by Fuhrmann, (1932): "nous ne savons pas si le type du genre, *Monopylidium musculosum* Fuhrmann possède une ou deux couronnes de crochets."

The taxonomic status of the species which have been reported from *P. domesticus* in North America is as follows:

Family Dilepididae Fuhrmann, 1907.
  Subfamily Dilepidinae Fuhrmann, 1907.
    Genus *Paricterotaenia* Fuhrmann, 1932.
      Syn: *Choanotaenia* Fuhrmann, 1908 (nec Railliet, 1896).
        Icterotaenia Railliet and Henry, 1909.
        Parachoanotaenia Lühe, 1910.

    Species *Paricterotaenia parina* (Duj., 1845) Fuhrmann, 1932.
      Syn: *Taenia parina* Duj., 1845.
        Taenia parina Krabbe, 1869.
        Drepanidotaenia parina Stossich, 1898.
        Choanotaenia parina Cohn, 1899.
        Choanotaenia parina Marotel, 1899.
        Choanotaenia parina Clerc, 1906.
        Icterotaenia parina Railliet and Henry, 1909.
        Choanotaenia parina Meggitt, 1916.
        Icterotaenia parina Baer, 1925.

  Subfamily Dipylidiinae Stiles, 1896.
    Genus *Choanotaenia* Railliet, 1896.
      Syn: *Monopylidium* Fuhrmann, 1899.
        Prochoanotaenia Meggitt, 1920.
        Multitesticulata Meggitt, 1929.
        Viscoia Mola, 1929.

    Species *Choanotaenia passerina* (Fuhrmann, 1907).
      Syn: *Monopylidium passerinum* Fuhrmann, 1907.

Description.

The measurements of the present specimens are given in Table I. Since generic and specific distinctions are based largely on the number and arrangement of rostellar hooks and on the form of the uterus, additional data concerning these structures are presented. In sections of the scolex of Alabama specimens, the hooks have a circular arrangement on the retracted rostellum; they are uniform in length and are disposed in a single row. In whole mounts, when the rostellum is partially retracted, the hooks often manifest an irregular or alternating arrangement, probably the result of unequal muscular tension, and this condition simulates a double row. The presence, at the distal end of the rostellum, of large cells with granular cytoplasm, between which the ends of the hooks are interposed, was noted. Although there is no criterion by which the definite nature of these cells can be ascertained, it is probable that they perform some function contributory to hook formation. The neck region and scolex are covered with fine cuticular spines, those of the neck proper being somewhat longer than those of the suckers.

TABLE I.
Comparative Measurements of Cestodes from Sparrows.

Structure	*C. passerina* Johnston (1909)	*P. passerellae* Cooper (1921)	Alabama specimens	*P. parina* Linton (1927)
Scolex; breadth	0.15–0.17 mm.	0.20 (length 0.14)	0.136–0.153 mm.	0.24–0.16 mm.
Suckers; diam.	0.08 mm.	0.09 mm.	0.055–0.06 mm.	0.10 mm.
Sucker cavity; depth	0.04 mm.		0.055–0.06 mm.	
Rostellum; length	0.11 mm.		0.105 mm.	
Rostellum; diam.	0.02–0.08 mm.	0.072 mm.	0.05 mm. max.	
Number of hooks	about 20	about 20	about 20	about 20
Length hooks	row I 0.016mm. row II 0.018mm.		0.016 mm.	0.015 mm.
Neck	length 0.04 mm. breadth 0.11–0.13	length 0.16 mm. breadth 0.20 mm.	Variable	
Genital cloaca; depth	0.025 mm.		Variable	
Ventral vessel; width	0.11 mm.		0.026–0.068 mm.	
Dorsal vessel; width	0.004 mm.		0.011 mm.	
Testes; diam.	0.05 mm.	0.075 mm.	0.075 (0.065–0.089)	
Cirrus sac; length	0.17–0.20 mm.	0.25–0.27 mm.	0.195 (0.174–0.27 mm.)	
Cirrus sac; diameter	0.04 mm.	0.056 mm.	0.036 (0.03–0.045 mm.)	
Ovary; width	0.18–0.22 mm.	0.32–0.36 mm.	0.39 (0.32–0.45 mm.)	
Vitelline gland; length	0.04–0.06 mm.	0.13 mm.	0.067 (0.04–0.08 mm.)	
Vitelline gland; width	0.05–0.08 mm.	0.11 mm.	0.11 (0.08–0.14 mm.)	
Eggs; diameters	outer 0.05 mm. inner 0.04 mm.	inner? 0.025–0.03 mm.	outer 0.056 mm. inner 0.048 mm.	outer inner 0.045–0.033 mm.
Onchospheres	0.024 mm.		0.026 mm.	0.03 mm.
Onchosphere hooks	0.012 mm.		0.014 mm.	0.018 mm.
Mehlis gland		length 0.07 mm. width 0.045–5	width 0.06 (0.04–0.07 mm.)	

The uterus was noted to be initially sacciform, later anastomosing and finally divided into small chambers, corresponding rather closely to the description given for this stage and structure in *C. infundibulum* by Ransom (1909). In the anastomosing condition the uterus was observed to ramify over the segment, occupying any portion medial to the dorsal excretory vessels. At the interstices of the channels, one or a few eggs or developing embryos were observed. The uterus persists as a thin-walled structure, and, while embryos appear to be free in the parenchyma when observed under ordinary magnification, observation of frontal sections with oil immersion lenses makes apparent the folded condition of the uterine wall.

DISCUSSION.

Reference to the data presented in Table I shows that in general the material from Alabama compares favorably with that described by Johnston (1909) and with that obtained from *P. domesticus* in Illinois by Hopkins and Wheaton (1935). The latter authors gave no measurements other than length, and stated that their specimens agreed in all essential respects with the description of Johnston. This description recorded the presence of two rows of rostellar hooks, one slightly anterior to the other, the hooks in the two rows varying in length by 0.002 mm. Hopkins and Wheaton observed that most of the ripe (gravid?) proglottids were found free in the intestine. In the present specimens, a few gravid proglottids were attached to the strobilae, although most of them had become detached and were free in the intestinal contents. Investigators who fail to collect detached proglottids may not recover those segments in which the form of the uterus has reached its definitive condition.

The genera *Choanotaenia* and *Paricterotaenia* are differentiated principally on the basis of the structure of the uterus. In members of the former genus the uterus is divided into pockets; this structure in the latter remains sacciform throughout. The terms "sacciform," "lobulate" and "anastomosing" have been used to describe the uteri of the various species within the genus *Paricterotaenia.* The possibility of interpreting a transitional uterus in a posterior segment of a member of the genus *Choanotaenia* as that of a member of *Paricterotaenia* appears admissible.

Cooper (1921) considered specimens recovered from the fox sparrow, *Passerella iliaca,* sufficiently different from *P. parina* to allow the establishment of the new species *Choanotaenia passerellae* (*Paricterotaenia passerellae* according to Fuhrmann, 1932). Hopkins and Wheaton observed a close similarity between their specimens and those which Cooper described as *C. passerellae,* and, upon re-examination of the latter specimens, found that uterine pockets are present. These investigators, however, failed to record further resemblances or differences which might have been derived from the comparison. By reason of the observed deviation of *P. passerellae* from the morphology typical of the genus *Paricterotaenia,* Hopkins and Wheaton have stated that: "if the form of the uterus is a valid generic characteristic, *P. passerellae* must remain in *Choanotaenia.*"

Linton (1927) recorded the characteristics and measurements of *P. parina* from the sparrows of North America (see Table I), but failed to consider the form of the uterus in his report. Meggitt (1916), in reporting this species from British birds, has also overlooked this point. Furthermore, that portion of the description of *P. parina* by Marotel (1899) used by Cooper in indicating significant differences between *P. parina* and *P. passerellae* contains no mention of the configuration of the uterus. That a close resemblance exists between *P. passerellae,* the material collected recently, and that reported by Johnston (1909) is evidenced by the Table appended. In most cases Cooper's measurements coincide, within reasonable limits, with either those of Johnston or with those taken from the Alabama material. Major discrepancies are to be observed by comparisons of the neck, vitelline gland, and cirrus. The neck and vitelline gland vary more with contraction and expansion of the segments that do the testes and the scolex with its structures. The cirrus sac, however, is moderately constant, varying but little in the sexually mature segments of the strobilae. Information as to the number of individuals measured and their condition is necessary, therefore, to elucidate the true status of *P. passerellae.* The probability of synonymy of the two species disregards the fact that *P. passerellae* has been recovered from the stomach of its host, whereas *C. passerina* is an intestinal parasite. Cestodes, however, are known to migrate from the intestine after death of the host, and have been found in the stomachs of animals dead for a long period.

Hopkins and Wheaton found that: "in the bilobed form of the ovary, and in several other features our specimens (which were identified as *Choanotaenia passerina*) and Johnston's material resemble *Paricterotaenia parina*." Upon this basis they have suggested the synonymy of the two species, although examination of the type material, which would have allowed a more definite statement regarding the true status of these species, was not possible due to its inaccessibility. It will be recalled that Fuhrmann (1932) placed the two species mentioned in different subfamilies, whereas Ransom (1909) considered them as members of the same group.

Upon the basis of these facts it seems possible that further investigation of the species of *Paricterotaenia* may necessitate the relegation of some of them to the genus *Choanotaenia*. The number of species of cestodes in the North American sparrow is at present uncertain; further investigation is necessary to negate or confirm the concept of generic or specific identity.

The specimens obtained by Hopkins and Wheaton were taken from birds which presumably had frequented the cages of infested chickens. Ackert and Reid (1937) have shown that the cysticercoid stage of *C. infundibulum* can be carried in the body of *Musca domestica*, and that flies so infected transmit the parasite to the chicken. It appears that flies may serve as intermediate hosts of *C. passerina*, and if the life history can be completed experimentally, a method for testing the host specificity of this parasite is available. Furthermore, it would be possible to determine whether or not *C. passerina* is distinct from *C. infundibulum*. Such a test, using infected flies in an attempt to parasitize young chicks with *C. passerina*, is contemplated.

SUMMARY.

54 specimens of *P. domesticus*, taken in Alabama, provided 23 cestodes which have been tentatively identified as *Choanotaenia passerina*.

In sections of the retracted rostellum the hooks of these specimens appear to be arranged in a single row. In whole mounts with partially retracted rostellum the hooks exhibit an alternating or irregular arrangement which may simulate a double row.

The uterus is sacciform, anastomosing, and divided into uterine pockets in successive stages of its development. The above conditions suggest the possibility of diverse interpretations of material taken at different levels from identical specimens.

A method for testing the host specificity of *C. passerina* is suggested, depending upon the infection of *M. domestica* with the cysticercoids of *C. passerina*.

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12.

Further Studies on the Susceptibility and Acquired Immunity of Marine Fishes to *Epibdella melleni*, a Monogenetic Trematode.

ROSS F. NIGRELLI

New York Aquarium.

(Plate I).

The presence of various degrees of susceptibility and resistance of marine fishes in the New York Aquarium to *Epibdella melleni* has been pointed out by Nigrelli and Breder (1934). This is the first instance of the development of an acquired immunity to an external trematode parasite.

The present preliminary paper deals with the actual count of parasites on the fish after successive exposures to infection and the determination of the degree of immunity developed.

The fishes employed for these experiments were two species of pompanos, *Trachinotus carolinus* and *T. falcatus*. The intensity with which these forms become infected is shown in Plate I. In this photograph of *T. falcatus*, small immature and larger matured parasites are easily noticed. The pompanos were collected at Sandy Hook Bay, N. J., brought into the Aquarium and kept in reserve tanks with running New York Bay water. As was pointed out by Nigrelli (1935 a), the trematodes are unable to live in sea water with a low specific gravity (i.e., 1.010-1.0128) like that of the Bay, so that the fishes at no time prior to the experiments were exposed to *Epibdella*.

After marking the animals, they were placed in the closed salt water system containing the parasites. In all the tests the counts were made at the end of 11-day periods. Before each count was made the fishes were removed from the tank, dipped for two minutes in a 10% solution of "solargentum" in fresh water and the parasites rubbed off. They were then allowed to rest for 3 days in tanks containing running Bay water. The results of these experiments are given in Tables I-V.

EXPERIMENTAL RESULTS.

In the first series, the common pompano, *T. carolinus*, was employed. The results have been previously reported as an abstract (Nigrelli, 1935 c).

Fish A (Table I) was given periodic injections of .2 cc. of serum taken from immunized pompanos of the same species. Although this fish outlived all the others in the series there are no definite indications that the resistance acquired was a passive one developed as a result of the injection of the serum. In this specimen complete immunity occurred after 5 successive exposures, or within 65 days. The resistance persisted for one year and two months, at which time the fish died of causes inherent in animals kept in captivity. The controls, Fish D and E, starting with a lighter initial infection, developed a resistance 14 days earlier and sustained it for 6 and 4 months respectively. One other control, Fish G, exposed to the infection 29 days after the experiment was started, obtained a light initial infection

TABLE I.

Number of worms present on *Trachinotus carolinus* at the end of each 11-day period.

	I	M	T	I	M	T*	I	M	T	I	M	T	I	M	T	I	M	T	L
A	606	250	856	270	0	270	143	26	169	16	13	39	15	0	15	0	0	0	1 yr., 2 mos.
B	423	279	702	290	0	290	296	58	354										50 days
C	117	59	176	85	0	85													21 days
D	169	76	245	60	0	60	69	45	114	33	5	38	0	0	0	0	0	0	6 mos.
E	112	122	234	75	0	75	44	14	58	12	16	38	0	0	0	0	0	0	4 mos.
F	164	134	298	130	0	130													21 days
G							287	101	388	35	13	48	0	0	0	0	0	0	8 mos.
H							25	3	28										12 days
I							30	5	35	12	3	15	0	3	3				45 days

* 5 day exposure; I, immature; M, mature; T, total; L, length of life of the fish after the experiment was started.

but developed a complete immunity at the end of second exposure and sustained it for 8 months. Fish B received a .5 cc. injection of ground dried worms suspended in salt water while Fish C received a similar amount of ground fresh worms. Here again the effects are not definite, in each case the fish dying early in the course of the experiment.

Although other species of *Epibdella* (e.g., *E. bumpusi* Linton on *Dasyatis centrura*) have been described from elasmobranchs, the present form has never been found on such hosts. It has long been known that very susceptible fishes kept in tanks containing dogfish, sharks, or rays either lack the parasites or become so lightly infected that no appreciable effects can be noted. Fish H and I in the above Table show this phenomenon, both of which were placed in a tank with many dogfish. Their early demise resulted from other unknown causes.

In the second series 3 fish (*T. falcatus*) were given intraperitoneally .1 cc., .25 cc. and .5 cc. respectively, of serum taken from an immunized grouper. In all cases a super-infection occurred as will be noted by the counts in Table II. The only reason for publishing this data is the interesting fact that from 6 fish (none over 4 inches in length) over *four thousand* worms were removed. Fish 3 of the controls, however, showed definite signs of developing a resistance, having an initial infection at the end of the first 11-day period of 774 worms, 384 in the second and 201 at the end of the third interval. Three days later after being re-exposed to infection the fish died. A count of the parasites yielded a total of 20 immature forms. It is altogether possible that some of the parasites had left the moribund or dead fish so that the last count may not be entirely accurate.

In the third series, one specimen of *T. falcatus* was injected with .25 cc. of serum taken from Fish G (*T. carolinus*) of the first experiment. The latter had sustained its resistance for 8 months, at which time it was used as a blood donor for the present experiment. The injected fish died at the end of the first period but the number of parasites was much lower than that found on the control. The latter lived for 4 periods and showed signs of acquiring a resistance to the parasites, although the count in the second interval was slightly higher than the first.

TABLE II.

Number of worms present on *Trachinotus falcatus* at the end of each 11-day period.

	I	M	T	I	M	T	I	M	T	I	M	T*	L
A′	502	165	667										14 days
B′	385	137	522										14 days
C′	702	151	853										14 days
1.	402	111	513										14 days
2.	582	170	752										14 days
3.	619	155	774	302	82	384	180	21	201	20	0	20	46 days

* Results of a 3-day infection.

The lower count resulting from the injection of immune serum might indicate that antibodies were formed which could be transferred to another fish to yield a passive immunity of a certain degree. The data obtained from the results of injection of sera from immunized fishes are not sufficient, however, to warrant the statement that definite protective antibodies are formed.

In the fourth series the two species of pompanos received periodically .25 cc. of either ground dried or fresh worms suspended in sea water. Like those recorded for Fish B and C in Table I, the results are unsatisfactory. However, Fish A″ (round pompano) did acquire a resistance at the end of the fourth exposure that lasted until the fish died 6 months later. This fish as well as Fish C″ (common pompano) was injected with .25 cc. of ground fresh worms before each exposure. The latter specimen, however, died before a complete immunity developed. Fish B″ and D″ (round and common pompanos respectively) died early in the progress of the experiment after receiving .25 cc. ground dried worms. The controls 1 and 2 also died before a complete immunity had developed, but definitely demonstrated the ability of these fish to build up a resistance to a super-infection. Superficially, the results of this experiment might indicate that the injection of ground fresh worms is effective in producing an immunity.

In another series of experiments (Nigrelli, 1935 b), an attempt was made to determine what part, if any, the mucus played in the protection of the fish to *Epibdella.* Accordingly, the parasites were removed, washed thoroughly in salt water and placed in petri dishes containing mucus from (1) immune grouper, (2) dogfish, (3) ray, (4) round pompano, and (5) salt water (control). The dogfish and ray show a natural immunity and never become infected, whereas the pompano is very susceptible. The parasites

TABLE III.

Number of worms present on *Trachinotus falcatus* at the end of each 11-day period. Fish T was injected with .25 cc. of serum taken from immunized Fish G (*T. carolinus*) shown in Table I.

	I	M	T	I	M	T	I	M	T	I	M	T	L
T	65	4	69										11 days
Control	233	76	309	255	60	315	181	13	194	22	2	24	59 days

TABLE IV.

Number of worms present on two species of pompanos at the end of each 11-day period. Fishes A″ and C″ were given .25 cc. of ground fresh worms. Fishes B″ and D″ were injected with a similar amount of ground dried worms. Fishes 1 and 2 are the controls.

	I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	L
A″	122	37	159	83	21	101	20	6	26	3	8	11	0	0	0	0	0	0	6 Mos.
B″	172	60	232	110	41	151													25 days
C″	133	26	159	82	31	121	16	8	24	10	12	22	6	2	8	4	0	4	86 days
D″	162	76	238																
1.	192	123	315	132	82	214	104	30	134	62	15	77							58 days
2.	142	60	202	68	12	80	6	10	16										43 days

in the mucus from the dogfish were moribund in 3 hours, and in 5 hours practically all were dead.

Those in mucus from the immune grouper were moribund in 4 hours and dead in 8 hours. Most of the parasites in mucus from the ray were dead in 4 hours. Those in mucus from the pompano were kept alive from 18-24 hours, while those in sea water remained alive for 3 days.

Attempts were then made to see what effects the injection of such mucus in fish would have in the development of a resistance to the trematodes. The results are shown in Table V. Fish A_1'' (common pompano) and Fish B_1 (round pompano) each were given .5 cc. of mucus taken from skate and dogfish respectively. Both died 3 days following the injection. Fish C_1 and D_1 each received .5 cc. sea water suspension of mucus from ray and immune grouper. The former showed signs of developing a definite resistance, yielding a total of 597, 323 and 157 worms in each successive period. In the fourth trial, however, a definite breakdown of this partial immunity occurred for no apparent reason, producing 389 worms. This individual died two days later in Bay water. Fish D_1 also showed an almost complete immunity before it died 71 days later. Fishes 1 and 2 were used as controls. Here again, a definite resistance developed to successive exposures. Fish 2

TABLE V.

Number of worms found on two species of pompanos at the end of each 11-day period.

	I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	I	M	T	L
A_1	167	0	167																			3 days
B_1	109	0	109																			3 days
C_1	482	115	597	273	50	323	136	21	157	302	87	389										58 days
D_1	503	112	615	180	70	250	101	14	115	20	1	21	10	14	24							71 days
1.	380	60	424	211	48	259	186	46	232	102	16	118										58 days
2.	413	72	485	170	33	203	80	10	24	0	6	6	2	3	5	0	0	0	0	0	0	125 days

shows this phenomenon very strikingly. The number of worms dropped from an initial count of 485 in the first period to 24 in the fourth. An extremely light infection persisted in the next 3 successive trials, finally yielding no worms in the last two trials (8 and 9). This fish died after 3 days in Bay water, in all probability from handling, to which this species is very sensitive.

ADDITIONAL OBSERVATIONS ON SUSCEPTIBILITY.

A large variety of fish hosts were found to be susceptible to *Epibdella melleni* in the New York Aquarium (Nigrelli and Breder, 1934). It was found at that time that all the hosts belong to the Order Acanthopteri or spiny-rayed fishes. Other forms belonging to this group that were not previously recorded and have since been found susceptible are *Therapon jarbua, Psettis argentus* and *Scatophagus argus,* all East Indian species. These forms become highly infected and are readily killed by the parasites. Another group found to be susceptible to a super-infection of the trematodes are the European wrasses. A collection of such fishes was wiped out within three weeks and a count from one fish (12 inches) at the end of one 11-day period yielded over 2,000 parasites in various stages of growth.

When the more susceptible fishes are removed from the closed circulation, those that formerly showed a natural immunity eventually take on a very light infection. Thus, in such instances various species of West Indian parrot fishes became infected. Three fish, examined at the end of one 11-day period, each produced 30, 21 and 80 small parasites. At such times, a few individual sea catfish (*Galeichthys milberti*) also became parasitized. In this form the infection is limited to the eyes (cornea) and never with more than a half-dozen worms. This is the only non-spiny rayed fish in the Aquarium to become infected with *Epibdella.*

DISCUSSION.

The development of resistance to metazoan parasites has been demonstrated in several host species. Investigations of Ackert, Africa, Chandler, Cort, Fujinami, Miller, Ozawa, Stoll and others have shown definitely that an immunity is developed against such helminthic parasites as trematodes, cestodes and nematodes. Darling (1922) was the first to study this problem of metazoan immunity by making actual counts of hookworms after anthelminthic treatments. The disadvantages of this method for internal parasites are many. In 1923, Stoll developed a technique for counting the eggs of the parasites in faeces and showed that a correlation existed between the eggs per gram of faeces and number of worms parasitizing the host. This method (with slight modifications) is used today in studies on susceptibility and immunity of animals to internal metazoan parasites.

Miller (1931) was able to determine the degree of resistance that albino rats develop against infection with the larval tapeworm, *Cysticercus fasciolaris,* by counting the number and determining the size of the cysts formed in the liver.

In this series Miller has definitely shown that "An active acquired immunity to a metazoan parasite, *Cysticercus fasciolaris,* has been artificially produced in the albino rat by periodic injections of fresh or powdered worm material." Miller and Gardiner (1932) further demonstrated that a passive immunity occurred in rats by intraperitoneal injections of serum from infected rats or from those actively immunized against *Cysticercus fasciolaris.*

Nigrelli and Breder (1934) have shown that a large number of fishes become infected with *Epibdella.* In analyzing this data they found that (a) some fish acquire a total immunity lasting for long periods; (b) some acquire a partial immunity; (c) certain fishes that appear to have a natural

immunity will become slightly infected during periods of epidemics; and (d) certain fishes are always susceptible and may show a heavy or light infection. In one form, the black angelfish, an apparent inverse age immunity appeared to be present. In this case the young acquired an immunity after a very short period of susceptibility (one to two weeks) while the older members were always parasitized. It has been further shown that in the moonfish, *Vomer setapinnis,* a skin immunity is present. Re-infection never takes place in the region of the previous infection, indicating a tendency toward localized immunity.

The existence of definite immunity to *Epibdella melleni* is further demonstrated in the present studies by actual count of the parasites after successive exposures to re-infection. The attempts to produce a resistance by periodic injections of ground dried and fresh worms gave indefinite results. In each case the controls were equally or more effective in producing a partial or complete immunity after several exposures. The injections of sera from immunized fishes were equally ineffective. The effects, if any, resulted in a breakdown of any inherent resistance so that the initial infection was in the majority of the cases higher than that of the controls. This is shown in Tables I (Fish A) and II. The individual shown in Table III, however, developed a very light initial infection, with only 69 worms present at the end of one 11-day period. This fish was injected with .25 cc. of serum taken from Fish G (Table I) which had developed a complete resistance at the end of the second exposure and had sustained it for 8 months, or up to the time it was used as a blood donor. As pointed out by Taliaferro (1934), although no protective antibodies can be demonstrated in many of the acquired helminthic immunities, "Extreme caution must, however, be exercised in excluding antibodies because most of the immunities are probably local and may involve antibodies produced locally which when diluted in the blood stream are not demonstrable." The parasiticidal action of fish mucus is very indicative of this local phenomenon. It may be that immune bodies are produced locally and sent out with mucus secretion, or as in some instances (elasmobranchs) the mucus itself may be toxic to the parasites. The fact that in the sea catfish the parasites are limited to the eyes is very suggestive. It is well known that there are no mucoid secreting cells around the eyes of fishes. Further experiments along these lines are now in progress.

SUMMARY.

1. Two species of pompanos (*Trachinotus carolinus* and *T. falcatus*) are shown to be very susceptible to infection with *Epibdella melleni,* a monogenetic trematode of marine fishes.

2. These fishes may acquire a permanent or partial resistance to the parasites after several exposures to the infection.

3. The results obtained from injecting dried and fresh worm material, as well as sera from immunized fishes, are unsatisfactory. In each series attempted, the controls developed either a partial or complete immunity which was just as effective, if not more so, than those subjected to the injections.

4. It has been found that worms placed in petri dishes containing mucus taken from elasmobranchs and immunized fish will die in a shorter time than when placed in mucus taken from a susceptible fish or when kept in sea water. Such mucus, however, when injected into susceptible fish gave indifferent results.

5. Other spiny-rayed fishes, not previously recorded, were found to be susceptible to the infection. The sea catfish (*Galeichthys milberti*) is the first and only non-spiny rayed fish to become infected. However, the infection is very light and always limited to the eyes.

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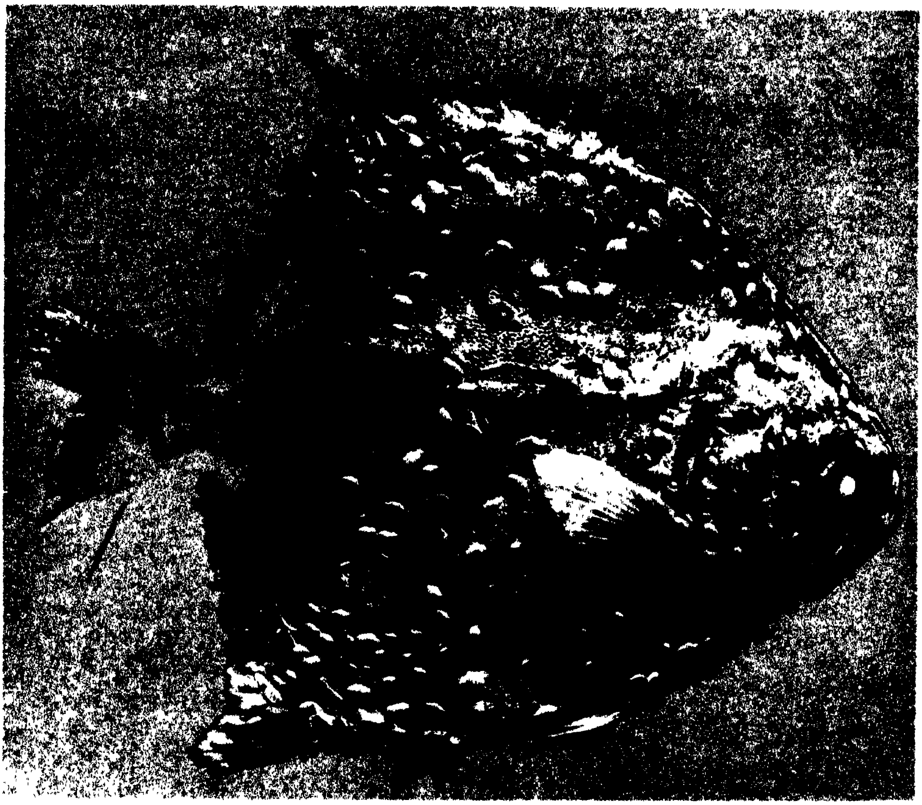
EXPLANATION OF THE PLATE.

PLATE I.

Fig. 1. *Trachinotus falcatus* (Round pompano), showing a super-infection with *Epibdella melleni*, an ectoparasitic trematode. 2x natural size.



FURTHER STUDIES ON THE SUSCEPTIBILITY AND ACQUIRED IMMUNITY OF MARINE FISHES TO EPIBDELLA MELLENI, A MONOGENETIC TREMATODE.

13.

Further Notes on Certain Birds of Paradise.

LEE S. CRANDALL

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RED BIRD OF PARADISE.
Uranornis rubra (Daudin).

The first male Red Bird of Paradise received at the Zoological Park arrived on December 27, 1915. During following years, three other males were obtained, the last on January 22, 1936. Notes on molt show periods that correspond, in general, with those observed in *Paradisaea.*[1] A young male, showing no development of head decoration, and lacking flank plumes and tail wires, began to molt on May 3, 1932. He appeared to have finished on August 10, 1932, requiring three months, as in immature males and all females of *Paradisaea.* In this molt, no plumes appeared but short, round wires, with feathered tips, were produced.

In the following year, the molt did not begin until June 25. Due to illness of the Curator, no date of the finish was recorded. During this molt, full head color, short flank plumes and short, flattened, slightly curved wires, were produced.

In 1934, the expected requirement of four months for the molt of the adult male, was established. This began on May 21 and was complete by September 25. The flank plumes were noticeably longer and better developed than those of the previous year. The wires, also, were much longer and fully spiral.

During the period following 1915, male Red Birds of Paradise were under almost constant observation but beyond occasional flapping of the wings, no attempt at display was noted. The short, stiff and recurved flank plumes suggested a display form of interest. It seemed almost certain that it must differ from that of *Paradisaea.*

The bird received in 1936 was in rather poor condition, with wires and plumes badly broken. However, he began molting in April and by the middle of August had completely finished. The length and development of the accessory plumage indicated that the bird was fully adult. In spite of all evidence of excellent condition, it was not until March 31, 1937, that the display was first seen. Early in that month, it became necessary to renew the perch then in use. A twisted section of red cedar was obtained which happend to have a branch extending downward from the trunk at an angle of about forty-five degrees. This appears to have been a most fortunate change, as this slanting branch took an important part in the display.

When first noticed, the bird was standing quietly, his body held stiffly parallel to the perch, with the head plumage fully distended. He then moved his wings slightly away from his body and vibrated them with great rap-

[1] *Zoologica,* Vol. XI, No. 7, December 8, 1932.

idity. The body was suddenly jerked to an erect position, and the wings were extended, the vibrating still continuing. The bird then lowered his body and started slowly down the slanting branch. When he reached the tip, the head being lower than the tail, he remained in fixed position for about twenty seconds. During this time the wings still were slightly spread and vibrating. The plumes were very slightly elevated, extending just above the body line, but distinctly not spread. As far as could be determined, their only function was to fill the spaces between tail and quivering wings.

When this form of frontal display had been completed, the bird turned about and hopped slowly up the branch. He leaped clear of the perch at each jump, alternating the feet in the forward position. This action caused the body to jerk violently from side to side, bringing the red plumes into greater prominence. Reaching the trunk of the cedar, he picked violently at a protruding knot and resumed the normal position.

This display routine was noted on several subsequent occasions, and showed no noteworthy variations. It seems quite possible that the presence of a slanting perch may be necessary for the full performance, since the frontal form appears to be the most essential part.

TWELVE-WIRED BIRD OF PARADISE.
Seleucides melanoleucus melanoleucus (Daudin).

Molting data for this species in the Zoological Park show an average period of three months for adults of each sex. Specific records are: male, April 7 to July 15; March 20 to June 25; May 20 to September 1; female, April 1 to July 1; March 12 to June 15.

Of two birds received here in August, 1929, the supposed female eventually proved to be a male. This bird went through normal molts until 1934, when, at the completion of the molt, it showed black patches on the head, neck, breast and edges of the wings. In 1935, the molt began on March 15. On its completion, about June 24, the bird was entirely clothed in the plumage of the adult male, except for the middle secondaries, rump, upper tail coverts and tail, which remained chestnut. The abdomen remained barred, with a strong yellow infusion. Short wires and a few small yellow flank plumes were produced. In the molt of 1936, beginning March 20 and ending June 25, the full male plumage was assumed, including fully developed wires and flank plumes. This bird, showing no signs of male plumage until it had been here for five years, and requiring seven years for completion of the change, showed a longer period of immaturity than any other bird of paradise under observation here. There is also the fact that it appeared quite adult on arrival, so that its actual age is greater than indicated by the dates given.

Partial displays by Twelve-wired Birds of Paradise are quite commonly seen, but most adult males seem to be rather shy. It was not until the bird referred to above, which was particularly tame and fearless, had acquired his final plumage, that a more complete routine was observed.

On March 5, 1937, the bird was observed with his body held parallel to the perch. The green breast plate was widely extended, while the yellow feathers of the lower breast and abdomen were tightly compressed, forming a strong contrast. The short flank plumes were slightly spread in the perpendicular plane, barely extending above and below the body line. With wings tightly closed, the bird leaped sideways to the trunk of the perch, seized it with its powerful feet and turned slowly around it. He frequently repeated a sharp, metallic, single note, opening his mouth widely for each call, showing the bright green interior. When the turn had been completed, the bird leaped back to the branch from which he had started. With the body again stiffly horizontal, breast plate still extended, abdominal feathers

still compressed and plumes slightly expanded, the wings were rapidly opened and closed, ten or twelve times. The usual rustling sound made by the wings in flight, was not detected. The normal position was then assumed. On another occasion, the bird spiralled slowly down the trunk of the perch, head downward, instead of going directly around it.

The great grasping power of the feet in this species, and the resultant ease with which it moves about its perches, in any direction, may well be accounted for by the extraordinary development of the short muscles of the metatarsus.

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14.

Preliminary List of Bermuda Deep-sea Fish.[1]

Based on the Collections from Fifteen Hundred Metre-net Hauls, Made in an Eight-mile Circle South of Nonsuch Island, Bermuda.

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In the course of the oceanographic work of the Department of Tropical Research of the New York Zoological Society during the last nine years off the southern coast of Bermuda, we have concentrated our investigations on an eight-mile circle, the center of which is at 32° 12′ North Latitude, and 64° 36′ West Longitude, and nine miles south-southeast of Nonsuch Island.

In this circle Net Number 1 was drawn at a depth of 400 fathoms on April 3, 1929. Since that time on all possible occasions intensive trawling has been carried on in this same locality from the surface to a depth of 1,400 fathoms. More than 1,500 metre-net hauls have been made, besides 16 descents in the bathysphere from 250 to 3,028 feet.

Only about half of the captured fish have been monographed, but the work is progressing rapidly. We have often been asked for a general list or résumé of the deep-sea fish thus far taken within this circle, so without waiting for completion of study of all the forms I have compiled a preliminary check-list of names and numbers. The hundred-odd pelagic species have not been considered in this catalogue, and so far no attempt has been made to do any dredging on the bottom, so that our list excludes all strictly surface forms as well as abyssal flounders, bottom-living macrurids, etc.

A single sentence will show the value of this concentrated research: The volume of this eight-mile circle is one five-millionth of the volume of the seas of the world, while in it we have taken more than one-third of all the corresponding abyssal fish so far known to science. More specifically, from this extremely limited area we have brought up fishes representing at least 10 Orders, 46 Families, 65 Genera, 220 Species and 115,747 Individuals, almost all from depths below 300 or 400 fathoms, in strictly abyssal habitats. Thirty-one of these species have been described as new.

While it is not my intention at present to make any comparative study between these deep-sea fish and surface or shore forms, or between those taken at various depths, yet a few facts will help to make more real the fish fauna of this area. Members of the genus *Cyclothone* of the family Gonostomidae are among the smallest and the most delicate of all abyssal fish, and within our circle they are far and away the most abundant. If we consider only two species, *C. microdon* and *C. braueri*, which thus comprise less than 1%

[1] Contribution No. 529, Department of Tropical Research, New York Zoological Society. Contribution from the Bermuda Biological Station for Research, Inc.

of the whole, we find that in total numbers they compose four-fifths or 82% (94,684) of all the other deep-sea individual fish together.

Myctophidae or lantern-fish come next in abundance but with wholly different relative proportions. The 57 species of this family compose one-quarter of the whole, and their numbers amount to 10%. Still a third different ratio of factors is shown by Melanostomiatidae, which, with 36 species (16%), can show only 247 individuals, or a mere two-tenths of one per-cent.

The drastic effect on physical characters of fish entering and living under the conditions of darkness, great pressure and frigidity of the abysses of ocean is evident when we realize that out of the 46 families, only 5 contain true surface-living members. These are Anguillidae, Gadidae, Trichiuridae, Brotulidae and Ogcocephalidae.

Considering abundance of individuals the following 10 families are in the lead: Gonostomatidae, Myctophidae, Sternoptychidae, Melamphaeidae, Chauliodontidae, Paralepidae, Maurolicidae, Melanostomiatidae, Aceratiidae and Serrivomeridae. With the species of these 10 families amounting to only 60% of all, we find that the individual count comes to 98.8% of all the fish taken.

Luminosity is present as follows: in 50% of the orders, 39% of the families, 81% of the genera, 66% of the species and (thanks again to *Cyclothone* and Myctophidae) to 96.5% of all individuals.

The use of a submarine automatically recording pressure gauge has made the exact depths of the long hauls certain. The consistent and long-continued trawls of hundreds of nets at corresponding levels have established a very accurate basis for estimating upper and lower life levels of species, and the level of maximum abundance. Also very sound data have been obtained on relative abundance and rarity. Three examples will suffice. *Cyclothone microdon* and *C. pallida* are very closely related, and yet their totals are 57,512 and 505 respectively; two eels, *Serrivomer beanii* and *S. brevidentatus* are distinguished with difficulty and yet they show the inexplicable difference in numbers of 155 and 7; *Myctophum laternatum* and *M. fibulatum* bear the same extremely close relationship, and they in turn tally at 2,853 and 8 respectively. The value of figures such as these is confirmed by net to net and year to year catches. The *Myctophum* case will illustrate this. The captures during the three years 1929, 1930 and 1931 of *M. laternatum* were 1,047, 877 and 905, while the corresponding years yielded 4, 2 and 2 individuals of *M. fibulatum*.

I have appended a list of the published papers dealing directly with this collection of fish.

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
ALEPOCEPHALIDAE				
Anomalopterus megalops Beebe, 1933	1	1	31	700
Bathytroctes drakei Beebe, 1929	27	1-2	10-22	400-900
Bathytroctes rostratus Günther, 1878	89	1-4	9.5-56	500-1,000
Dolichopteryx binocularis Beebe, 1932	2	1	53-85	200-400
Dolichopteryx longipes (Vaillant), 1888	4	1	23-85	600-800

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Macromastax gymnos Beebe, 1933	1	1	35	1,000
Photostylus pycnopterus Beebe, 1933	1	1	64	800
Xenodermichthys copei (Gill), 1884	3	1	27-34	600-700
BATHYLAGIDAE				
Bathylagus benedicti Goode & Bean, 1895	20	1-2	18-91	400-1,000
Bathylagus glacialis Regan, 1913	99	1-3	24-135	500-1,000
STOMIATIDAE				
Macrostomias calosoma Beebe, 1933	1	1	430	600
Stomias brevibarbatus Ege, 1918	22	1	19-225	400-1,000
Stomias ferox Reinhardt, 1842	96	1-6	23-90	300-1,000
MELANOSTOMIATIDAE				
Bathophilus altipinnis Beebe, 1933	1	1	63	800
Bathophilus brevis Regan & Trewavas, 1930	4	1	13-26	300-900
Bathophilus chironema Regan & Trewavas, 1930	1	1	34	1,000
Bathophilus longipinnis (Pappenheim), 1914	2	1	48-61	400-900
Bathophilus metallicus (Welsh), 1923	22	1-2	25-105	300-900
Bathysphaera intacta Beebe, 1932	2	....	1829	350
Chirostomias pliopterus Regan & Trewavas, 1930 (= *C. lucidimanus* Beebe, 1932).	8	1	19-225	300-700
Echiostoma tanneri (Gill), 1883	13	1	61-375	500-900
Eustomias bibulbosus Parr, 1927	8	1	42-123	500-900
Eustomias bigelowi Welsh, 1923	1	1	108	700
Eustomias fissibarbis (Pappenheim), 1914	1	1	130	800
Eustomias frondosus Regan & Trewavas, 1930	1	1	43	500
Eustomias lipochirus Regan & Trewavas, 1930	1	1	50	500
Eustomias obscurus Vailliant, 1888	5	1	51-98	500-700
Eustomias paucifilis Parr, 1927	1	1	134	800
Eustomias satterleei Beebe, 1933	1	1	140	1,000

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Eustomias schiffi Beebe, 1932	3	1	43-115	600
Eustomias schmidti Regan & Trewavas, 1930	2	1	55-118	700-800
Eustomias simplex Regan & Trewavas, 1930	1	1	91	600
Flagellostomias boureei (Zugmayer), 1913	10	1	7-97	0-1,000
Lamprotoxus angulifer Beebe, 1932	4	1	34-145	400-700
Lamprotoxus flagellibarba Holt & Byrne, 1910	3	1	29-206	500-700
Leptostomias bermudensis Beebe, 1932	1	1	285	500
Leptostomias ramosus Regan & Trewavas, 1930	20	1-2	12-52	50-1,000
Melanostomias bulbosus Beebe, 1933	1	1	222	700
Melanostomias spilorhynchus Regan & Trewavas, 1930	54	1-3	17-240	400-1,000
Pachystomias atlanticus Regan & Trewavas, 1930	1	1	38	500
Photonectes bifilifer Beebe, 1933	1	1	245	800
Photonectes braueri (Zugmayer), 1913	1	1	62	900
Photonectes cornutus Beebe, 1933	1	1	19	600
Photonectes dinema Regan & Trewavas, 1930	26	1-2	24-51	1,000
Photonectes intermedius Parr, 1927	4	1	49-70	400-800
Photonectes leucospilus Regan & Trewavas, 1930	15	1	25-33	300-1,000
Photonectes margarita (Goode & Bean), 1895	6	1	245-300	500-1,000
Photonectes mirabilis Parr, 1927	3	1	18-28	600
Photonectes parvimanus Regan & Trewavas, 1930	10	1	14-44	0-800
MALACOSTEIDAE				
Aristostomias photodactylus Beebe, 1933	1	1	84	700
Aristostomias tittmanni Welsh, 1923	14	1	30-62	500-1,000
Malacosteus niger Ayres, 1849	26	1-2	20-206	500-1,000
Photostomias guernei Collet, 1889	99	1-3	23-145	500-1,000
Ultimostomias mirabilis Beebe, 1933	1	1	40	900
ASTRONESTHIDAE				
Astronesthes gemmifer Goode & Bean, 1895	7	1	21-26	400-700

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Astronesthes niger Richardson, 1845	47	1-2	24-35	300-1,000
Neonesthes nicholsi Beebe, 1933	8	1	26-156	500-1,000
CHAULIODONTIDAE				
Chauliodus danae Regan & Trewavas, 1930	380	1-8	8-113	300-1,000
Chauliodus sloanei Bloch & Schneider, 1801	413	1-9	16-245	300-1,000
GONOSTOMATIDAE				
Bonapartia pedaliota Goode & Bean, 1895	6	1-2	15-55	200-800
Cyclothone microdon (Günther), 1878	57,512	1-268	10-62	300-1,000
Cyclothone braueri Jespersen & Tåning, 1926	37,172	1-471	10-25	100-1,000
Cyclothone pallida Brauer, 1906	505	1-10	20-45	300-1,000
Gonostoma bathyphilum (Vaillant), 1884	5	1	56-165	700-1,000
Gonostoma elongatum Günther, 1878	40	1-2	21-270	400-1,000
Photichthys nonsuchi Beebe, 1932	1	1	89	600
Yarrella blackfordi Goode & Bean, 1895	5	1	16-33	400-1,000
IDIACANTHIDAE				
Idiacanthus fasciola Peters, 1876	129	1-8	16-270	100-1,000
MAUROLICIDAE				
Diplophos taenia Günther, 1873	1	1	35	600
Ichthyococcus ovatus (Cocco), 1838	198	1-5	9.3-31	300-1,000
Maurolicus muelleri (Gmelin), 1789	2	1	7-8	500-800
Valenciennellus tripunctulatus (Lütken), 1870	6	1-2	9-27	100-1,000
Vinciguerria attenuata (Cocco), 1838	219	1-5	7-19	300-1,000
Vinciguerria nimbraria (Jordan & Williams), 1896	4	1-2	14-30	400-800
OPISTHOPROCTIDAE				
Opisthoproctis soleatus Vaillant, 1888	1	1	51	450
STERNOPTYCHIDAE				
Argyropelecus aculeatus Cuvier & Valenciennes, 1849	139	1-12	6-55	300-1,000
Argyropelecus affinis Garman, 1899	2	2	44-48	400

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Argyropelecus hemigymnus Cocco, 1829	295	1-9	5-35	300-1,000
Argyropelecus young (Not yet studied)	691	1-26	6-12	100-1,000
Sternoptyx diaphana Hermann, 1781	1,337	1-9	5-41	0-1,000
HALOSAURIDAE				
Halosaurus sp.	1	1	155	900
ANGUILLIDAE				
Anguilla anguilla (Linnaeus), 1758	26	1-2	20-50	100-1,000
Anguilla rostrata (Le Sueur), 1817	19	1	30-63	500-1,000
SYNAPHOBRANCHIDAE				
Synaphobranchus kaupi Johnson, 1862	11	1-2	63-88	500-900
DERICHTHYIDAE				
Derichthys serpentinus Gill, 1884	18	1	55-268	500-1,000
NESSORHAMPHIDAE				
Nessorhamphus ingolfianus Schmidt, 1930 (Schmidt, 1912)	21	1-2	26-166	400-1,000
SERRIVOMERIDAE				
Serrivomer beanii Gill & Ryder, 1883	155	1-5	55-440	50-1,000
Serrivomer brevidentatus Roule & Bertin, 1929	7	1	73-512	500-800
Platuronides acutus Parr, 1932	22	1	18-178	100-1,000
Platuronides danae Roule & Bertin, 1929	7	1-2	31-488	50-1,000
NEMICHTHYIDAE				
Nemichthys scolopaceus Richardson, 1848	45	1-2	40-360	50-1,000
Avocettina infans Günther, 1876	1	1	498	1,000
Labichthys carinatus Gill & Ryder, 1883	3	1	200-470	500-1,000
CYEMIDAE				
Cyema atrum Günther, 1878	4	1	50-105	800-1,000
EURYPHARYNGIDAE				
Eurpharynx pelecanoides Vaillant, 1882	84	1-3	30-506	500-1,000
SACCOPHARYNGIDAE				
Saccopharynx harrisoni Beebe, 1932	1	1	1,400	900

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
PARALEPIDAE				
Luciosudis sp.	3	1	32-35	500-1,000
Macroparalepis intermedius Ege, 1933	1	1	130	500
Macroparalepis sp.	19	1	8-87	100-900
Paralepis brevirostris (Parr), 1928	60	1-2	8-50	300-1,000
Paralepis brevis Zugmayer, 1911	662	1-7	9-87	300-1,000
Paralepis bronsoni (Parr), 1928	1	1	90	800
Paralepis speciosus? Bellotti, 1877	7	1-2	18-90	500-900
MYCTOPHIDAE				
Diaphus agassizi Gilbert, 1908	2	1	27-34	500-900
Diaphus dofleini Zugmayer, 1911	192	1-12	9-29	300-1,000
Diaphus dumerili (Bleeker), 1856	7	7	54-66	0
Diaphus effulgens (Goode & Bean), 1895	6	1	10-43	500-900
Diaphus fulgens (Brauer), 1904	93	1-9	9-16	300-1,000
Diaphus garmani Gilbert, 1906	1	1	48	0
Diaphus gemellari (Cocco), 1838	27	1-4	10-28	300-1,000
Diaphus hypolucens Parr, 1928	5	1-2	10-12	400-1,000
Diaphus lucidus (Goode & Bean), 1895	4	1	9-11	500-900
Diaphus lutkeni (Brauer), 1904	1	1	42	1,000
Diaphus macrophus Parr, 1928	294	1-14	9-45	300-1,000
Diaphus metopoclampus (Cocco), 1829	13	1	20-80	300-1,000
Diaphus rafinesquei (Cocco), 1820	134	1-9	9-70	400-1,000
Diaphus splendidus (Brauer), 1904	1	1	13	600
Diaphus young (Not yet studied)	122	1-20	8-13	300-1,000
Lampadena anomala Parr, 1928	10	1-3	17-26	500-800
Lampadena bathyphila Tåning, 1928	21	1	17-61	600-1,000
Lampadena braueri Zugmayer, 1914	54	1-3	10-32	300-1,000
Lampadena chavesi (Collet), 1905	9	1	20-27	500-1,000
Lampadena minima Tåning, 1928	5	1	26-40	500-1,000

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Lampanyctus ater Tåning, 1928	23	1-2	7-47	500-1,000
Lampanyctus crocodilus (Risso), 1810	95	1-6	15-32	300-1,000
Lampanyctus cuprarius Tåning, 1928	208	1-6	9-101	50-1,000
Lampanyctus elongatus (Costa), 1844	11	1	13-30	400-1,000
Lampanyctus festivus Tåning, 1928	7	1-2	26-29	500-900
Lampanyctus gaussi (Brauer), 1906	2	1	12-23	400-600
Lampanyctus guntheri Goode & Bean, 1895	42	1-8	16-52	400-1,000
Lampanyctus intricarius Tåning, 1928	1	1	32	700
Lampanyctus lineatus Tåning, 1928	2	1	30-50	600
Lampanyctus longipes (Brauer), 1906	4	1	12-20	800-1,000
Lampanyctus micropterus (Brauer), 1906	2	1	19-21	500
Lampanyctus niger (Günther), 1887	1	1	37	900
Lampanyctus nobilis Tåning, 1928	3	1-2	14-22	800-1,000
Lampanyctus photonotus Parr, 1928	1	1	14	500
Lampanyctus polyphotis Beebe, 1932	60	1-5	7-67	400-1,000
Lampanyctus photothorax Parr, 1928	891	1-20	9-37	300-1,000
Lampanyctus pusillus (Johnson), 1890	942	1-13	10-38	300-1,000
Lampanyctus resplendens Richardson, 1844-1848	14	1	23-37	600-1,000
Lampanyctus septilucis Beebe, 1932	3	1-2	28-31	700
Lampanyctus subpectoralis Parr, 1928	153	1-11	14-39	200-1,000
Lampanyctus supralateralis Parr, 1928	27	1-4	13-27	400-1,000
Lampanyctus taaningi Parr, 1929	350	1-7	13-58	500-1,000
Lampanyctus warmingi (Lütken), 1892	880	1-47	9-40	400-1,000
Myctophum affine (Lütken), 1892	37	1-2	13-25	400-1,000
Myctophum benoiti (Cocco), 1838	1,294	1-67	5-40	300-1,000
Myctophum coccoi (Cocco), 1829	165	1-3	7-26	300-1,000
Myctophum fibulatum Gilbert & Cramer, 1897	8	1-2	12-25	400-900

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
Myctophum glaciale (Reinhardt), 1837	2	1	26-28	700-900
Myctophum humboldti (Risso), 1810	2	2	21	1,000
Myctophum hygomi (Lütken), 1892	131	1-7	11-38	300-1,000
Myctophum imitator Parr, 1928	30	1-3	10-22	400-1,000
Myctophum laternatum Garman, 1899	2,853	1-43	9-22	100-1,000
Myctophum macrochir (Günther), 1864	170	1-5	10-44	300-1,000
Myctophum nigro-ocellatum (Günther), 1889	13	1-2	11-19	500-600
Myctophum rarum (Lütken), 1892	10	1	21-26	500-1,000
Myctophum reinhardti (Lütken), 1892	72	1-4	11-35	100-1,000
Myctophum rufinum Tåning, 1928	6	1	20-28	600-700
Myctophum valdiviae Brauer, 1904	846	1-44	9-23	300-1,000
Myctophid young (Not yet studied)	1,646	1-67	7-16	0-1,000
SCOPELARCHIDAE				
Scopelarchus anale (Brauer), 1902	14	1	18-130	500-1,000
EVERMANNELLIDAE				
Evermannella atlantica Parr, 1928	1	1	35	500
Evermannella balbo (Risso), 1820	8	1	20-39	400-900
Evermannella melanoderma Parr, 1928	38	1	17-31	300-1,000
OMOSUDIDAE				
Omosudis lowii Günther, 1887	134	1-3	5-180	400-1,000
ALEPISAURIDAE				
Alepisaurus ferox Lowe, 1833	122	1-4	7-190	500-1,000
RONDELETIIDAE				
Rondeletia bicolor Goode & Bean, 1895	2	1	97	600-1,000
CETOMIMIDAE				
Genera & spp.	11	1-2	30-105	700-1,000
Bathyembryx istiophasma Beebe, 1934	1	....	600	416
MACRURIDAE				
Macrurus spp.	5	1	64-68	500-1,000

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
BREGMACEROTIDAE				
Bregmaceros atlanticus Goode & Bean, 1895	35	1-2	9-75	400-1,000
GADIDAE				
Laemonema barbatula Goode & Bean, 1883	1	1	72	900
Melanonus unipinnis Beebe, 1932	50	1-2	9-75	400-1,000
Physiculus kaupi Poey, 1865	1	1	35	100
MELAMPHAEIDAE				25-1,000
Anoplogaster cornutus (Cuvier & Valenciennes), 1833	22	1-2	4-48	
Caulolepis longidens Gill, 1883	7	1	90-151	700,-1,000
Melamphaes cristiceps Gilbert, 1891	61	1	17-105	500-1,000
Melamphaes megalops Lütken, 1877	1	1	41	700
Melamphaes microps (Günther), 1878	989	1-18	9-36	300-1,000
Melamphaes mizolepis (Günther), 1878	65	1-2	8-56	300-1,000
Melamphaes nigrofulvus Garman, 1899	1	1	93	700
Melamphaes robustus Günther, 1887	306	1-4	13-42	100-1,000
Melamphaes typhlops (Lowe), 1843	5	1	13-52	400-1,000
Melamphaes young	600	1-14	6-13	300-1,000
TRICHIURIDAE				
Benthedesmus atlanticus Goode & Bean, 1895	2	2	200-205	In stomach of *Parathunnus atlanticus*
ACROPOMATIDAE				
Oxyodon sp.	51	1-4	9-40	400-1,000
CHIASMODONTIDAE				
Chiasmodon spp.	27	1	8-220	500-1,000
Odontonema sp.	1	1	85	900
Pseudoscopelus stellatus Beebe, 1932	8	1-2	14-45	25-1,000
BROTULIDAE				
Brotula spp.	8	1	7-50	700-900
Parabrotula dentiens Beebe, 1932	1	1	28	800
Parabrotula sp.	3	1	30-31	700-1,000
Mixonus laticeps (Günther), 1878	1	1	43	700
LOPHIIDAE				
Lophius sp.	1	1	14	1,000

	Number of Specimens.	Number in Single Nets.	Size Range (mm.).	Depth Range (fathoms).
OGCOCEPHALIDAE				
Dibranchus sp.	4	1	25-28	600
LINOPHRYNIDAE				
Linophryne arborifera Regan, 1925	5	1	1.3-31	600-800
Linophryne brevibarbata Beebe, 1932	2	1	26-33	700-900
Edriolychnus sp.	2	1	23-30	900
Haplophryne spp.	3	1	11-18	700-1,000
ONEIRODIDAE				
Chaenophryne crossotus Beebe, 1932	1	1	17	500
Chaenophryne draco Beebe, 1932	1	1	18	600
Chaenophryne longiceps Regan, 1925	1	1	42	1,000
Dolopichthys analogus Parr, 1927	2	1	17	500-600
Dolopichthys gladisfenae Beebe, 1932	1	1	40	700
Dolopichthys longicornis Parr, 1927	2	1	27-42	900-1,000
Dolopichthys tentaculatus Beebe, 1932	3	1	14-17	600-900
Lasiognathus beebei Regan & Trewavas, 1932	1	1	38	600
Lophodolus acanthognathus Regan, 1925 (= *L. lyrae* Beebe, 1932)	45	1	10-47	600-1,000
MELANOCETIDAE				
Melanocetus spp.	12	1	9-86	0-1,000
CERATIIDAE				
Bathyceratias trilychnus Beebe, 1934	1	....	152	411
Cryptosparas cousii Gill, 1883	24	1	10-28	0-1,000
Mancalias uranoscopus Murray, 1878	1	1	17.5	900
ACERATIIDAE				
Aceratias edentula Beebe, 1932	1	1	19.6	1,000
Aceratias spp.	91	1-3	3-19	500-1,000
Rhynchoceratias spp.	128	1-2	8-36	25-1,000
FAMILY UNDETERMINED				
Bathysidus pentagrammus Beebe, 1934	1	....	152	316

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15.

The Templeton Crocker Expedition. X. Echinoderms from the West Coast of Lower California, the Gulf of California and Clarion Island[1].

FRED C. ZIESENHENNE
Virginia Barret Gibbs Scholar, 1936-37,
Museum of Comparative Zoölogy, Cambridge, Massachusetts.

(Text-figures 1 & 2).

[Note: This is the tenth of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica*, No. 2, pp. 33 to 46.]

CONTENTS.

[1] Contribution No. 529, Department of Tropical Research, New York Zoological Society.

INTRODUCTION.

The collection of echinoderms made by the Templeton Crocker Expedition of the New York Zoological Society on the yacht *Zaca* to the Gulf of California and adjacent waters in the spring of 1936 is of great interest. With the exception of *Ophiura lütkeni*, of which there are 1,844 specimens, the collection is rich in quality but not in quantity. It consists of 2,277 specimens representing 65 species, viz., 27 sea-stars, 21 ophiurans, 16 echini and 1 crinoid[2]. There are two new brittle-stars which are described in this report. No fewer than 28 species are represented by only one or two specimens and some of these species have not been taken previously since they were described more than 20 years ago. A number of specimens were badly crushed and in poor condition; only one sea-star, however, was unidentifiable.

The region explored is on the boundary between the Panamic fauna and the North Pacific fauna; however, 31 species have been previously taken in the Panamic region, 22 species are of the North Pacific fauna, while 12 species are confined to the Gulf of California. It is interesting that several species were taken that had not been recorded since Verrill described them in 1871. The farther south one collects it becomes more and more evident that the North Pacific littoral species occur only in the deeper water; most of the material was taken at depths of less than 100 fathoms. The richest littoral stations were Santa Inez Bay in the Gulf of California, and Sulphur Bay, Clarion Island. Of the new brittle-stars one belongs to the large genus *Ophiacantha*, while the other is a representative of the genus *Ophiuroconis*.

I wish to express my indebtedness to Dr. William Beebe for the opportunity of studying this interesting material. Thanks are also due to Dr. H. L. Clark and Dr. E. Deichmann for their invaluable help in working up the material, and to Dr. W. K. Fisher for his expert assistance in determining some of the difficult sea-stars. Dr. Deichmann and Dr. Fenner A. Chace, Jr., have generously read the proofs.

The field color notes were made by members of the expedition.

The specimens are all deposited in the collections of the Museum of Comparative Zoölogy, Cambridge, Massachusetts.

[2] The holothurians taken have been discussed by Dr. E. Deichmann in the present volume of *Zoologica*, pp. 161 to 176.

Class Crinoidea.

Family Antedonidae.

Florometra perplexa (A. H. Clark).

Antedon perplexa A. H. Clark, 1907, p. 74.

Florometra perplexa, A. H. Clark, 1921, p. 60, pl. 62, figs. 95, 96; pl. 5, figs. 1009-1014.

Type: Cat. No. 22611, U. S. N. M.

Type Locality: Off the coast of Washington, *Albatross* Station No. 3070.

General Range: From Alaska and Monterey Bay to the Gulf of Panama and the Galápagos Islands. From 45 to 581 fathoms.

Local Distribution: One adult from west of San José Point, Lower California (Station 175:D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: This interesting crinoid is the only one in the collection. It is a good-sized specimen and the color in life was reddish-brown, pinnules dark brown to black, cirri light brown. Length of arms 111 mm., longest cirrus 33 mm.

Class Asteroidea.

Family Astropectinidae.

Astropecten armatus Gray.

Astropecten armatus Gray, 1840, p. 181.

Astropecten armatus, Fisher, 1911, p. 56.

Type: British Museum.

Type Locality: Puerto Portrero, South America (Gray).

General Range: From San Pedro, California, to Punta Santa Elena, Ecuador. From shore to 80 fathoms.

Local Distribution: A total of 21 specimens was taken from Magdalena Bay, Gorda Banks, Arena Bank, the Inez area and Clarion Island between three feet and 80 fathoms on muddy, sandy and rocky bottoms.

Remarks: This series is composed mainly of young specimens ranging in size from R = 5 mm. to R. = 146 mm.; the ratio between arms and disk radius rises from R = 2.5 r to R = 5.5 r. The supero-marginal spines are developed even in the smallest individuals. The color in life was usually pink, sometimes scarlet. The color of the dried specimens ranges from pale green to light brown, with the small ones cream color.

Material: Magdalena Bay: (2 young). Station 136: D-1 (3 young). Station 142: D-1 (1 adult). Station 143: D-1 (3 young), D-3 (5 young). Station 145: D-1 (1 adult). Station 150: D-9 (1 young), D-13 (2 young), D-16 (2 young). Station 163: D-3 (1 young).

Astropecten californicus Fisher.

Astropecten californicus Fisher, 1906, p. 299.

Astropecten californicus, Fisher, 1911, p. 61.

Type: No. 157, Stanford University Invertebrate Collection.

Type Locality: Monterey Bay, California; 70 fathoms.

General Range: From north of Bodega Head, California, to Lower California, Mexico. From 10 to 244 fathoms.

Local Distribution: A total of five specimens was taken off San José Point, Lower California, from east of Cedros Island and on Gorda Banks between 38 and 70 fathoms on muddy and shaley bottoms.

Remarks: This series is composed entirely of young individuals, ranging from R = 13 mm. to R = 22 mm. The color of the dried specimens is brown in diverse shades; color in life pinkish.

Material: Station 126: D-1 (1 young). Station 150: D-4 (1 young) Station 175: D-1 (3 young).

Thrissacanthias penicillatus (Fisher).

Persephonaster penicillatus Fisher, 1905, p. 297.

Thrissacanthias penicillatus, Fisher, 1911, p. 79.

Type: Cat. No. 22329, U. S. N. M.

Type Locality: Off Los Coronados Islands, southwest of San Diego, California. From 530 to 638 fathoms.

General Range: From Washington to Lower California. From 30 to 822 fathoms.

Local Distribution: One young individual was taken in Santa Inez Bay (Station 142: D-2) at a depth of 30 to 35 fathoms on a bottom composed of mud and crushed shell.

Remarks: Although no young specimen in the M. C. Z. collection is as small as the *Zaca* specimen, comparison shows that this individual is probably the young of *T. penicillatus,* but it is the first specimen recorded from the Gulf of California, and the first from a depth of less than 277 fathoms. R = 6 mm.; r = 2 mm. The color (dried) is light brown with lighter rays.

Sideriaster canaliculata A. H. Clark.

Sideriaster canaliculata A. H. Clark, 1916, p. 52.

Type: Cat. No. 36951, U. S. N. M.

Type Locality: Gulf of California, 40 fathoms, *Albatross* Station 2998.

General Range: Gulf of California, Santa Inez Bay to Arena Bank. From 35 to 60 fathoms.

Local Distribution: A total of 12 specimens was taken from Gorda Banks, Arena Bank and the Inez area between 35 and 60 fathoms on muddy bottoms.

Remarks: These are the first specimens to be collected since the species was described in 1916. The series is interesting because of the diversity in size, ranging from R = 4 mm. to R = 87 mm. In the smallest specimen, R = 2 r but as growth proceeds, R increases disproportionately until in the largest it considerably exceeds 3 r. A. H. Clark's type has R = 64 mm. and r = 19. The color of the larger dried specimens at hand is brownish-white, the color in life was pinkish to coral red.

Material: Station 136: D-14 (1 young). Station 142: D-3 (2 adults, 2 young). Station 146: D-1 (1 young). Station 147: D-2 (1 young, tip of an adult ray). Station 150: D-9 (5 young).

Family Luidiidae.

Luidia bellonae Lütken.

Luidia bellonae Lütken, 1865, p. 133.

Luidia bellonae, H. L. Clark, 1910, p. 330.

Type: Probably in Copenhagen.

Type Locality: Guayaquil, Ecuador.

General Range: Gulf of California to Iquiqui, Chile, and the Galápagos Islands. From 2 to 30 fathoms.

Local Distribution: A total of 4 specimens was taken from Santa Inez Bay, Station 142: D-1 (1 adult), and Station 143: D-1 (3 young), between 29 and 30 fathoms on muddy bottoms.

Remarks: This series was in very poor condition, probably being broken in the dredge. Largest specimen R = 115 mm.; r = 13 mm. The smaller specimens were in too poor condition to permit measurement. The color of the large specimen was lavender in life, and, dried, it is gray with dark cross-bands on the arms. The dorsal spines are light gray; the longest are 4 mm. in length; marginal spines about 5 mm. long, gray at base with white tips.

Luidia columbia (Gray).

Petalaster columbia Gray, 1840, p. 183.

Luidia columbia, Sladen, 1889, p. 247. H. L. Clark, 1910, p. 331.

Type: British Museum.

Type Locality: "St. Blas," probably the west coast of Mexico.

General Range: From Magdalena Bay and the Gulf of California to northern Peru and the Galápagos Islands. From two to 80 fathoms.

Local Distribution: A total of 15 specimens was taken from east of Cedros Island, from Gorda Banks, Arena Bank, Santa Inez Bay and Clarion Island, between two and 80 fathoms on muddy, sandy and hard bottoms and in coral (*Pocillopora ligulata*).

Remarks: This series ranges in size from R = 8 mm. to R = 213 mm. The color of the dried specimens is brown of diverse shades, with white spines and oral surface. Several specimens have white and brown irregular markings on the disk and arms. The color in life was coral pink with orange spines.

Material: Station 126: D-3 (1 adult). Station 127: D-1 (tip of ray). Station 136: D-1 (1 adult), D-33 (1 adult). Station 142: D-3 (2 young). Station 143: D-3 (3 young). Station 147: D-2 (1 adult, 3 young). Station 150: D-13 (1 adult), D-16 (1 adult). Station 163: D-3 (1 adult).

Luidia foliolata Grube.

Luidia foliolata Grube, 1866, p. 59.

Luidia foliolata, Fisher, 1911, p. 106.

Type: Unknown.

Type Locality: Unknown.

General Range: From southeast Alaska (Kasaan Bay) to San Diego, California, and probably to Mazatlan. From 10 to 189 fathoms, usually less than 80 fathoms.

Local Distribution: Three specimens were taken west of San José Point, Station 175: D-1 (1 adult, 2 young), at a depth of 45 fathoms.

Remarks: These specimens are well preserved and in good condition. Size ranges from R = 15 mm.; r = 4 mm. to R = 91 mm.; r = 8 mm. The color of the dried specimens is brown with white spots irregularly scattered on the disk and arms; bordering the marginal plates are rows of white paxillae; oral surface dirty yellow.

The known range is extended to Lower California by this record which is the farthest south the species has been taken.

Luidia phragma H. L. Clark.

Luidia phragma H. L. Clark, 1910, p. 329.

Type: No. 398, M. C. Z.

Type Locality: Probably Peru.

General Range: Gulf of California to Peru. From three feet to 30 fathoms.

Local Distribution: A total of four specimens was taken on the shore of Magdalena Bay and in Santa Inez Bay at three feet and 13 fathoms.

Remarks: Of this colorful species the smallest specimen has R = 35 mm., the largest R = 45 mm. The third row of paxillae from the marginal plates bears spines. The color of the dried specimens is gray, with each arm having a brown stripe down the center; the margins have black bars, one in each inter-radius and 3 to 4 on the arms, but in one specimen these bars are not so distinct. The oral side and lateral spines are white.

Material: Magdalena Bay: (1 adult). Station 145: D-1 (3 adults).

Family Odontasteridae.

Odontaster crassus Fisher.

Odontaster crassus Fisher, 1904, p. 302.

Odontaster crassus, Fisher, 1911, p. 156.

Type: Cat. No. 22333, U. S. N. M.

Type Locality: Albatross Station 4313, vicinity of San Diego. From 92 to 243 fathoms.

General Range: Monterey Bay to San Diego, and northern Lower California. From 43 to 243 fathoms.

Local Distribution: One young specimen was taken west of San José Point (Station 175: D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: The specimen has R = 12 mm. The color (dried) is cream on the marginal plates and oral side; the paxillar area is light brown.

The known range is extended about 100 miles to the south by this record.

Family Goniasteridae.

Mediaster aequalis Stimpson.

Mediaster aequalis Stimpson, 1857, p. 530, pl. 23, figs. 7-11.

Mediaster aequalis, Fisher, 1911, p. 198.

Type: Cat. No. 1977, U. S. N. M.

Type Locality: Puget Sound, Washington, or San Francisco.

General Range: From the Alaska Peninsula (Chignik Bay) to northern Lower California. From 9 to 160 fathoms.

Local Distribution: A total of four specimens was taken west of San José Point, Lower California (Station 175: D-1, 2 young; D-3, 2 adults) at a depth of 45 fathoms on shaley bottom.

Remarks: The smallest specimen R = 7 mm., largest R = 38 mm. Color (dried) is a dirty cream; the madreporite is light buff; color of adults in life, bright red.

Amphiaster insignis Verrill.

Amphiaster insignis Verrill, 1868, p. 372.

Type: Cat. No. 581, M. C. Z. (cotype).

Type Locality: La Paz, Lower California.

General Range: Magdalena Bay and Gulf of California. From 30 to 45 fathoms.

Local Distribution: A total of 18 specimens was taken from Arena Bank and Santa Inez Bay between 18 and 45 fathoms on sandy and muddy bottoms.

Remarks: In the smallest specimen R = 9 mm.; in the largest R = 59 mm. The color (dried) is a light dirty brown; the color in life was pale pink to carrot red.

Material: Station 136: D-1 (1 young, 6 adults), D-2 (1 young), D-13 (1 adult), D-26 (2 young, 1 adult). Station 141: D-3 (3 adults). Station 142: D-1 (2 young). Station 143: D-1 (1 adult).

Family Oreasteridae.

Pauliella aenigma Ludwig.

Pauliella aenigma Ludwig, 1905, p. 151.

Type: Cat. No. 2403, M. C. Z. (cotype).

Type Locality: Cocos Island, off Costa Rica, *Albatross* Station 3368.

General Range: Cocos and Clarion Islands. From 45 to 67 fathoms.

Local Distribution: One specimen was taken off Clarion Island (Station 163: D-2) at a depth of 55 fathoms on a rocky bottom with coral.

Remarks: This specimen has R = 16.5 mm. and r = 11.5 mm.; a cotype in the M. C. Z. has R = 13.5 mm., r = 9.5 mm.; a large specimen with R = 16.5 mm. and r = 12 mm. was described by Ludwig and it agrees well with the present individual, especially in the ambulacral armature. The cotype and this individual differ from each other chiefly in the size of the dorsal and lateral spines. In the cotype the central dorsal spines, 5 in number (3 broken), are 1 mm. high, while the distal dorsal spines, arranged in 5 groups of 12 to 15, are 8 mm. high. The *Zaca* specimen has no central spines but 11 spheroidal naked plates surrounded at their base with series of granules. The distal dorsal spines are small and few, none exceeding 3 mm. in length. The inter-radial, intra-marginal spines are well developed in the cotype, where there are ten, conical and blunt, the longest 1 mm. in length. In the present specimen the intra-marginal spines are small and the area between the dorsal and ventral marginal plates is greatly reduced. These differences however are probably due to growth changes. With advancing age it may be that the spines are lost and the enlarged plates occupy their place.

The color (dried) is creamish-white both above and below; the triangular madreporite is light brown; each inter-radius dorsally has a light yellow area.

This is the first specimen of *Pauliella* to be recorded since the types were taken by the *Albatross* at Cocos Island in 1891. The known range is now extended to Clarion Island about 2,100 miles to the northwest.

Oreaster occidentalis Verrill.

Oreaster occidentalis Verrill, 1867a, p. 278.

Oreaster occidentalis, H. L. Clark, 1910, p. 333.

Type: Probably in Peabody Museum, New Haven.

Type Locality: West coast of Panama.

General Distribution: Gulf of California to northern Peru and the Galápagos Islands. From three to 40 fathoms.

Local Distribution: A total of three specimens was taken from Arena Bank and Santa Inez Bay between five and 45 fathoms on sandy and muddy bottoms.

Remarks: All the specimens at hand of this common species are small with R ranging from 47 to 91 mm. Their color in life ranged from orange to red; dried from alcohol it is brown with a reddish tinge; papular areas gray in both living and dried specimens.

Material: Station 136: D-6 (1 adult), D-23 (1 young). Station 141: D-1 (1 adult).

Nidorellia armata (Gray).

Pentaceros armatus Gray, 1840, p. 277.

Nidorellia armata, Verrill, 1867a, p. 280; H. L. Clark, 1910, p. 332.

Type: Probably in the British Museum.

Type Locality: Punta Santa Elena, Ecuador. From 12 to 15 fathoms.

General Range: From Guaymas, Mexico, to Zorritos, Peru, and the Galápagos Islands. From shore to 40 fathoms.

Local Distribution: A total of three specimens was taken off Arena Bank and off Santo Domingo Point, Santa Inez Bay, between one and 2½ fathoms in coral (*Pocillopora ligulata*) and on a sandy bottom.

Remarks: In the smallest specimen R = 55 mm., in the largest R = 72 mm. The color in life was olive with dark blue spines. The armature varies greatly; there are 33 short, blunt, dorsal spines on the smallest specimen, and two to four blunt marginal spines at ray tips; in the largest specimen there are 104 short pointed dorsal spines, and marginal spines on all but four superomarginal plates. The intermediate specimen has 16 long, blunt, dorsal spines 10 mm. high; superomarginal spines near tip of ray, about four on each side 6 mm. long.

Material: Station 136: D-33 (1 adult). Near Station 145: (2 adults).

Family Ophidiasteridae.

Linckia columbiae Gray.

Linckia columbiae Gray, 1840, p. 285.

Linckia columbiae, Fisher, 1911, p. 242.

Type: Probably in the British Museum.

Type Locality: "West coast of Colombia" (Gray).

General Range: San Pedro, California, to Colombia and the Galápagos Islands. From shore to 55 fathoms.

Local Distribution: A total of three specimens was taken from Arena Bank and off Clarion Island between 45 and 55 fathoms on muddy and rocky bottoms.

Remarks: The largest specimen has R = 55 mm., the smallest 51 mm. All have five arms, but one has two arms, 12 and 21 mm. in length, in process of regeneration. Color of the dried specimens light tan.

Material: Station 136: D-1 (2 adults). Station 163: D-2 (1 adult).

Narcissia gracilis A. H. Clark.

Narcissia gracilis A. H. Clark, 1916, p. 58.

Type: Cat. No. 38,317, U. S. N. M.

Type Locality: Albatross Station 2829, off Lower California, 31 fathoms.

General Range: Gulf of California. From 31 to 50 fathoms.

Local Distribution: A total of nine specimens was taken from Arena Bank and Gorda Banks between 45 and 50 fathoms on muddy and sandy bottoms.

Remarks: The specimens at hand are all young (R = 13 to 34 mm.) and are more depressed than the adults, which have the arms decidedly triangular in cross-section. The species is rare, only a few having been taken since the type was described in 1916. The color of the living specimens ranged from coral pink to burnt orange; dried, they are yellowish-brown.

Material: Station 136: D-1 (1 young), D-13 (1 young), D-23 (2 young), D-26 (4 young). Station 150: D-10 (1 young).

Phataria unifascialis (Gray).

Linckia unifascialis Gray, 1840, p. 285.

Phataria unifascialis, Sladen, 1889, p. 786; H. L. Clark, 1910, p. 335.

Type: Probably in the British Museum.

Type Locality: Bay of Caracas, west coast of Colombia.

General Range: From the Gulf of California to Zorritos, Peru. From shore to 10 fathoms.

Local Distribution: Two adults were taken from Arena Bank (Station 136: D-33) at a depth of two fathoms in coral (*Pocillopora ligulata*).

Remarks: This tropical species is abundant on rocky shores in the Panamic region and can easily be collected at low tide. The larger specimen in the *Zaca* collection has R = 58 mm., while in the smaller R = 45 mm.; both specimens show evidence of regeneration, so that neither is quite typical, the rays being short and heavy. The dried specimens are a bleached dirty cream color.

Pharia pyramidata (Gray).

Ophidiaster pyramidatus Gray, 1840, p. 284.

Pharia pyramidata, Sladen. 1889, p. 784; H. L. Clark, 1910, p. 335.

Type: Probably in the British Museum.

Type Locality: Bay of Caracas, west coast of Colombia, on rocks.

General Range: From the Gulf of California to Punta Santa Elena, Ecuador; Zorritos, Peru, and the Galápagos Islands. From shore to 10 fathoms.

Local Distribution: One adult was taken from Arena Bank (Station 136: D-33) at a depth of two fathoms in coral (*Pocillopora ligulata*).

Remarks: The specimen has R = 66 mm., and the color is brown with faded yellow papular areas.

Leiaster teres (Verrill).

Lepidaster teres Verrill, 1871a, p. 578.

Leiaster teres, Sladen, 1889, p. 408.

Type: Probably in the Peabody Museum, New Haven.

Type Locality: La Paz, Lower California.

General Range: Confined to the Gulf of California. From 20 to 30 fathoms.

Local Distribution: One adult specimen was taken from Gorda Banks (Station 150: D-7) between 20 and 30 fathoms on a muddy bottom.

Remarks: This specimen is the first one to be collected since Verrill's type was taken by Captain J. Pedersen near La Paz. Verrill says the type was "pale yellow" when dried; probably in had been in alcohol for some time. The present specimen in life was brilliant cerise pink; at present it has faded to a dull rose. In his "Echinoderms of Torres Strait" (1921, p. 73) H. L. Clark refers to Verrill's ambiguity about the papular arrangement, but the specimen now at hand shows clearly that the papulae are grouped, thus leaving no doubt that it is a true *Leiaster*. The *Zaca* specimen has R = 44 mm., about the same as in the type.

Family Echinasteridae.

Henricia asthenactis Fisher.

Henricia asthenactis Fisher, 1910, p. 572.

Henricia asthenactis, Fisher, 1911, p. 297.

Type: Cat. No. 27,782, U. S. N. M.

Type Locality: *Albatross* Station 4423 between Santa Barbara and San Nicholas Islands, California. From 216 to 339 fathoms.

General Range: Vicinity of Santa Barbara Islands, Shumagin Islands, Bering Sea (Bowers Bank and off Kamchatka), and the Gulf of California. From 67 to 682 fathoms.

Local Distribution: A total of three specimens was taken from Gorda Banks between 50 and 75 fathoms on muddy and hard bottoms.

Remarks: These specimens extend the range of the species over a thousand miles to the south. The adult differs slightly from the northern form, but since the species of this genus vary greatly, it does not seem desirable to make it a named variety. It has R = 17 mm., and the color in life was pinkish; dried it is cream with light brown papular areas. The two young specimens are six-armed, one regenerating three arms (R = 11 mm., other arms R = 19 mm.) and the other has two arms (R = 15 mm. and four buds with R = 5 mm.) The color is the same as in the adult.

Material: Station 150: D-9 (2 young), D-16 (1 adult).

Henricia aspera Fisher.

Henricia aspera Fisher, 1906, p. 127.

Henricia aspera, Fisher, 1911, p. 393.

Type: Cat. No. 21,930, U. S. N. M.

Type Locality: *Albatross* Station 3052, Heceta Bank, Oregon, 48 fathoms.

General Range: From Bering Sea (Bering and Pribilof Islands), south to San José Point, Lower California. From 26 to 313 fathoms.

Local Distribution: One specimen was taken west of San José Point (Station 175: D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: This specimen has R = 34 mm. It extends the known range of the species about 200 miles to the south.

Henricia leviuscula dyscrita Fisher.

Henricia leviuscula dyscrita Fisher, 1911, p. 298.

Type: Cat. No. 27,780, U. S. N. M.

Type Locality: Albatross Station 2907, near Point Conception, California, at 44 fathoms.

General Range: Middle California to Cedros Island. From off shore to about 80 fathoms.

Local Distribution: A total of five specimens was taken west of San José Point, and east of Cedros Island at 45 and 60 fathoms on bottoms of shale and crushed shell.

Remarks: The smallest has R = 23 mm., in the largest it is 37 mm. This material extends the known range about 300 miles southward. The color of the adult in life was buffy-yellow.

Material: Station 126: D-10 (1 adult). Station 175: D-2 (4 young).

Henricia polyacantha Fisher.

Henricia polyacantha Fisher, 1906, p. 129.

Henricia polyacantha, Fisher, 1911, p. 302.

Type: Cat. No. 21,932, U. S. N. M.

Type Locality: Albatross Station 2936, off San Diego, California, at 359 fathoms.

General Range: San Diego, California, to the Gulf of California. From 70 to 359 fathoms.

Local Distribution: One adult was taken from Gorda Banks (Station 150: D-13) at a depth of 70 to 80 fathoms on a rough bottom.

Remarks: The known range of *H. polyacantha* is extended about 100 miles to the south by this specimen which was pinkish in life, is pale cream color dried, and has R = 56 mm. This specimen is a southern variety but not distinctive enough to be named as a subspecies.

Echinaster tenuispinus Verrill.

Echinaster tenuispinus Verrill, 1871a, p. 577.

Echinaster tenuispinus, H. L. Clark, 1913, p. 195.

Type: Probably in Peabody Museum, New Haven.

Type Locality: La Paz, Lower California.

General Range: Confined to the Gulf of California. From shore to 10 fathoms.

Local Distribution: Two young specimens were taken from Santa Inez Bay (Station 144: D-2) at a depth of 2½ fathoms, and one adult from the tidal zone of the same bay. The bottom in both cases was sandy.

Remarks: In the smallest specimen R = 4 mm., while in the largest R = 42 mm. The color of the dried specimen is brown with only the spine tips light; orally the ambulacra are pale yellow with light-colored spines.

Family Acanthasteridae.

Acanthaster ellisii (Gray).

Echinaster ellisii Gray, 1840, p. 281.

Acanthaster ellisii, Verrill, 1869, p. 385.

Type: Probably in the British Museum.

Type Locality: South America?; H. Cuming, Esq., (Gray).

General Range: Gulf of California, Galápagos Islands and Clarion Island. From shore to 6 fathoms.

Local Distribution: One adult was taken from Sulphur Bay, Clarion Island, between one and 6 fathoms on a bottom formed of coral and rock.

Remarks: This seems to be a rare species, since less than a dozen specimens have been recorded. W. P. Sladen (*Rep. Voy. Challenger,* vol. 30, 1889, p. 536) doubts the validity of the species but later collectors have added specimens from other localities and it is now generally accepted.

One specimen when lifted into a boat was said to inflict a painful sting. Other specimens have been handled by the present writer without any stinging or other unusual sensations. It may be that a coelenterate had become accidentally enmeshed on the numerous spines of the sea-star and caused the stinging sensation reported. But it is possible that *Acanthaster* may possess poisonous pedicellariae as many sea urchins do. When more living specimens are taken, experiments should be carried out to determine the effect and source of the stinging, if any occurs.

The present specimen in life showed dorsally three concentric rings of rufous, apricot buff and rufous around a center of the apricot buff shades; spines dove gray basally, vinaceous pink distally; oral surface vinaceous pink; tube-feet greenish yellow; dorsal surface of rays dove gray, lateral portions rufous. In the dried specimen the dorsal spines are pale red, papular areas dark red, madreporites light gray, oral spines dirty white. There are 15 rays and 8 madreporitic plates; R = 85 mm. and r = 51 mm.

Family Heliasteridae.

Heliaster kubiniji Xantus.

Heliaster kubiniji Xantus, 1860, p. 568.

Heliaster kubiniji, H. L. Clark, 1913, p. 201.

Type: U. S. N. M.

Type Locality: Cerro Blanco, off Cape San Lucas, Lower California.

General Range: Gulf of California. From shore to five fathoms.

Local Distribution: Two small specimens were taken in three feet of water at Santa Inez Point, Santa Inez Bay, on a sandy bottom.

Remarks: This species is a common littoral form in the Gulf of California. Each of the present specimens has 23 rays, R = 60 mm.; r = 33 mm. Color (dried) dark brown, spines pale pink fading to white.

Family Asteriidae.

Sclerasterias heteropaes Fisher.

Sclerasterias heteropaes Fisher, 1928, p. 112.

Type: Cat. No. E. 1427, U. S. N. M.

Type Locality: Albatross Station 4554, N. W. Point Pinos, Monterey Bay, California, in 70 to 80 fathoms.

General Range: Half Moon Bay to south of San Diego, California, and Clarion Island. From 27 to 85 fathoms.

Local Distribution: A total of 11 specimens was taken west of San José Point, Lower California, and off Clarion Island at 45 to 55 fathoms on bottoms composed of shale and of rock with coral, respectively.

Remarks: This species is interesting in that the young may have either five or six arms (Fisher, 1928, p. 115). In the largest R = 21 mm., smallest

R = 8 mm. The color of dried specimens is brown, with two whitish bands on each arm, the spines white. The specimens from Clarion Island establish a new southern limit for the known range of the species.

Material: Station 163: D-2 (2 young). Station 175: D-1 (9 young).

CLASS OPHIUROIDEA.

Family Ophiomyxidae.

Ophiomyxa panamensis Lütken & Mortensen.

Ophiomyxa panamensis Lütken & Mortensen, 1899, p. 182.

Type: Cat. No. 2642, M. C. Z. (cotypes).

Type Locality: Albatross Station 3397, Panama.

General Range: Gulf of California to Panama. From 50 to 85 fathoms.

Local Distribution: A total of 15 specimens was taken from Arena Bank and Gorda Banks at depths of 50 fathoms on rocky and crushed shell bottoms.

Remarks: Unfortunately the specimens are crushed and broken but there is no doubt of their identity even though their occurrence near Lower California extends the known range of the species 2,000 miles to the north. The color of these specimens when dried is old rose; the disk, however, is dark red and the arm spines have yellow tips.

Material: Station 136: D-27 (7 disks and fragments). Station 150: D-10 (8 disks and fragments).

Family Gorgonocephalidae.

Astrocaneum spinosum (Lyman).

Astrophyton spinosum Lyman, 1875, p. 29.

Astrocaneum spinosum, Döderlein, 1911, p. 92.

Type: Cat. No. 2912, M. C. Z.

Type Locality: West coast of Panama.

General Range: Panama to Lower California. From 10 to 46 fathoms.

Local Distribution: One specimen from Ceralbo Channel, (Station 137: D-1) at a depth of 46 fathoms.

Remarks: This specimen extends the known range of the species more than 2,000 miles to the north. The diameter of the disk is 30 mm., length of arm about 110 mm. The color of the dried specimen is pale brown with a dark, dorsal median line on arms.

Family Ophiacanthidae.

Ophiacantha pyriformis sp. nov.

(Text-figure 1).

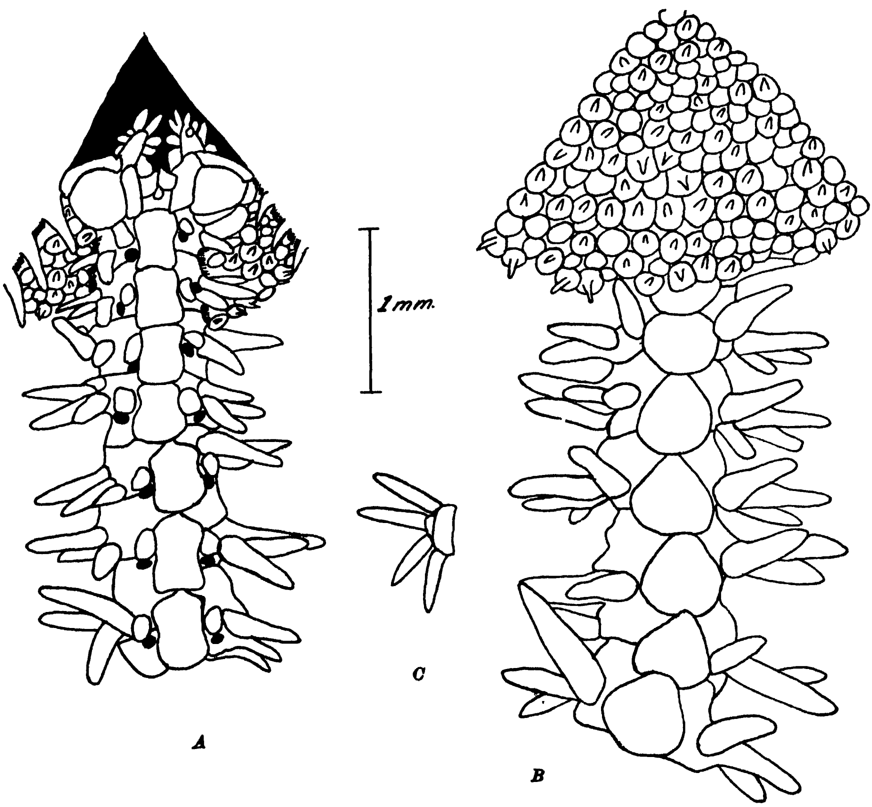
Diagnosis: Rays six; simple spinelets on disk scales; unique, well defined dorsal arm-plates; four short, stout, tapering arm-spines.

Description: Disk about 3 mm. in diameter, arms 6; old arms 13 mm. long; regenerated arms 6 mm. Disk covered with numerous, distinct, overlapping scales, each of the larger bearing a single, blunt, relatively smooth, tapering spinelet, less than 1 mm. in length; there is no definite arrangement in the distribution of spines. Radial shields covered with scales,

except at the distal margin. Basal upper arm-plates more or less circular, the second much larger than the first; subsequent plates becoming longer than wide but widest distally, pyriform, sharply defined, only slightly in contact with each other; the surface of all upper arm-plates is rough, like shagreen.

Interbrachial areas below covered with overlapping scales, some bearing short, blunt spines. Genital slits large. Oral shields oval, longer than broad, proximally more convex than distally. Adoral shields triangular, longer than broad, proximally pointed, increasing in width distally, meeting within in some areas, not in contact in others, due to regenerating rays. All plates more finely granulate than the upper arm plates. Teeth block-like and bluntly rounded, four in each column. Oral papillae two to four on each side of the jaw, according to the stage of growth, most proximal narrow and rounded; distally they become wider and flat with blunt tips; distal papilla widest. Second pair of oral tentacles with tentacle-scales.

First under arm-plate small, oval, distally and proximally convex; second and succeeding arm-plates longer than wide, sides slightly concave, proximal end pointed, distal margin broadly rounded; plates slightly in contact. Tentacle-scale single, large, oval and flat; distally it becomes slender and pointed. Side arm-plates large, narrowly separated above and below. Each



Text-figure 1.
Ophiacantha pyriformis sp. nov. **A**, oral side; **B**, aboral side; **C**, arm-spine arrangement.

plate bears four short, well spaced, smooth spines, tapering but blunt, the uppermost longest.

The color in dried alcoholic specimens is as follows: old arms and portion of the disk light brown; regenerated rays and parts of disk light gray; oral surface nearly white; arm-spines gray.

Type: M. C. Z. Cat. No. 5423 (holotype) and three paratypes (M. C. Z. 5424).

Type Locality: Clarion Island, Mexico.

Material: The holotype and three paratypes, taken off Clarion Island, (Station 163: D-1) at a depth of 20 fathoms on a bottom of rock and coral.

Remarks: Of the four specimens three have six arms, three large and three small, and one has three arms, the incomplete disk having four jaws. Evidently reproduction by fission when very young is the rule, but whether the adult has five or six arms, there is no means of knowing.

This species is readily distinguished from other species of the genus by the simple spinelets on the disk-scales, unique dorsal arm-plates and the four short stout arm-spines. It apparently is not closely allied to any known species, but additional material may show it to be the young of a larger, already named species.

Family Amphiuridae.

Amphiura arcystata H. L. Clark.

Amphiura arcystata H. L. Clark, 1911, p. 145.
Amphiura arcystata, Nielsen, 1932, p. 264.

Type: Cat. No. 3135, M. C. Z. (paratype).

Type Locality: Off Central California, *Albatross* Station 3132.

General Distribution: From California to the Gulf of California and Japan. From 30 to 330 fathoms.

Local Distribution: A total of seven specimens was taken east of Cedros Island and in Santa Inez Bay at 35 and 45 fathoms on muddy bottoms.

Remarks: The largest specimen is 12 mm. in disk diameter; while the longest arm measures 204 mm. The smallest specimen is 4 mm. across the disk and its longest arm is 40 mm. The dried specimens are light brown, the disk darker and radial shields lighter. This record extends the known range of the species to the Gulf of California, more than 1,200 miles to the south.

Material: Station 126: D-6 (3 adults). Station 143: D-4 (4 young).

Amphipholis squamata (Delle Chiaje).

Asterias squamata Delle Chiaje, 1828, p. 74.
Amphipholis squamata, Verrill, 1899, p. 312; Nielsen, 1932, p. 290.

Type: Unknown.

Type Locality: Mediterranean Sea, probably Naples.

General Range: Cosmopolitan, the most widely distributed of the brittle-stars. From shore to 100 fathoms.

Local Distribution: One specimen was taken east of Cedros Island (Station 125: D-1) at a depth of 44 fathoms on a muddy bottom.

Remarks: The disk diameter of the single specimen is 3 mm. with length of arms 7 mm. The disk is light gray, the arms light cream color in the dry specimen.

Amphiodia urtica (Lyman).

Amphiura urtica Lyman, 1860, p. 195.
Amphiodia urtica, Verrill, 1899, p. 313; Nielsen, 1932, p. 279.

Type: Never designated.

Type Locality: Puget Sound, Washington.

General Range: From Shumagin Islands, Alaska, to Lower California. From 15 to 50 fathoms.

Local Distribution: Three young specimens were taken east of Cedros Island (Station 125: D-1) at a depth of 44 fathoms on a muddy bottom.

Remarks: The diameter of the disk in the largest specimen is 4 mm., while that of the smallest is 2 mm. The arms are 17 mm. in length. The disk is gray and the arms are cream color in the present material. This is the farthest south the species has been recorded.

Ophiactis savignyi (Müller & Troschel).

Ophiolepis savignyi Müller & Troschel, 1842, p. 95.
Ophiactis savignyi, Ljungman, 1867, p. 323; Nielsen, 1932, p. 257.

Type: Unknown.

Type Locality: Egypt.

General Range: World-wide in the tropics; on the Pacific coast from San Pedro, California, to Panama. From shore to 27 fathoms.

Local Distribution: One young specimen was taken from Clarion Island (Station 163: D-1) at a depth of 20 fathoms on a bottom formed of coral and rock.

Remarks: This is a common tropical species, frequently found in sponges. The disk diameter of the present specimen is only 1.5 mm., length of arms, 7 mm. The dried specimen has the disk mottled green and black as usual and the arms marked with alternating bands of green and light brown.

Ophiopholis bakeri McClendon.

Ophiopholis bakeri McClendon, 1909, p. 41.
Ophiopholis bakeri, Nielsen, 1932, p. 261.

Type: Probably in the University of California, Berkeley.

Type Locality: La Jolla, California.

General Range: From British Columbia to Lower California. From 41 to 68 fathoms.

Local Distribution: A total of 15 adults was taken west of San José Point, Lower California (Station 175: D-1, 8 adults; D-2, 7 adults) at 45 fathoms on shaley and rocky bottoms.

Remarks: The diameter of the largest specimen is 7 mm., length of arms 32 mm.; the disk diameter of the smallest specimen is 2 mm., length of arms 7 mm. The dried specimens have a pink disk with white or gray markings. The arms, orange in life, are pink with an occasional light band; the armspines are white or gray.

Family Ophiotrichidae.

Ophiothrix galapagensis Lütken & Mortensen.

Ophiothrix galapagensis Lütken & Mortensen, 1899, p. 181.

Type: Cat. No. 2340, M. C. Z. (cotype).

Type Locality: Near the Galápagos Islands, *Albatross* station 3405.

General Range: Galápagos Islands, Clarion Island and the Gulf of California. From 20 to 75 fathoms.

Local Distribution: A total of 42 specimens was taken from Gorda Banks, Arena Bank, Santa Inez Bay and Clarion Island between 35 and 75 fathoms on sandy, muddy and rocky bottoms.

Remarks: These specimens are the first to be collected since 1899 when the species was described from three specimens. The known range of this species has been extended to Clarion Island and the Gulf of California, more than 2,000 miles to the north, by the present record.

All of the specimens are larger than the type, which had a diameter of only 5 mm. The largest specimen in the present series is 13 mm. in diameter. The arm length is about 75 mm.

In the live specimens the disk was purplish blue above spotted with red; arms pinkish-orange, each with a double line of dark oblong spots on upper surface; oral surface white. The color of the dried specimens varies greatly; the disk ranges from cream to maroon with white central markings; medial shields pink with red markings bordering the plates as a marginal line or irregular spotting; disk orally and arm-spines white; arms pink with a median longitudinal white line on dorsal surface.

This species occurred locally in great swarms. About 23,000 specimens, weighing 100 pounds altogether, were taken in a single 10-minute dredge (Station 150: D-18); at Station 150: D-16, 1,682 specimens, and at Station 150: D-4, 360 were captured.

O. galapagensis is related to *O. spiculata,* from which it differs by the raised and naked radial shields, by the pinkish color and red markings, by the larger size, longer spines and shape of the arm plates.

Material: Station 136: D-7 (7 adults), D-13 (1 adult), D-23 (1 adult), D-24 (2 adults). Station 142: D-3 (4 adults), Station 146: D-1 (3 adults). Station 147: D-2 (1 adult). Station 150: D-4 (8 crushed adults), D-16 (2 adults), D-18 (7 adults and fragments). Station 163: D-2 (6 adults, poor condition).

Ophiothrix spiculata Le Conte.

Ophiothrix spiculata Le Conte, 1851, p. 318.

Ophiothrix spiculata, Nielsen, 1932, p. 251.

Type: Cat. No. 2415, M. C. Z. (cotypes).

Type Locality: Panama (west coast).

General Range: From Monterey Bay, California, to the Bay of Sechura, Peru. From shore to 45 fathoms.

Local Distribution: A total of 18 specimens was taken east of Cedros Island, on Arena Bank and in Santa Inez Bay, between 1½ and 45 fathoms on sandy and muddy bottoms.

Remarks: These specimens are larger than the types. In life the arms are banded with pink and maroon or brown. The general color varies from light gray and brown to red in the dry specimens. The most colorful of the series has blue radial shields and red disk spines; the arms are blue with a red band about every fourth arm-plate. The arm-spines are dark at the base but become lighter toward the tips. The diameter of the largest specimen is 12 mm., arm length about 40 mm. The smallest specimen has a disk diameter of 5 mm.

Material: Station 126: D-3 (1 adult). Station 128: D-1 (5 adults). Station 136: D-1 (4 adults), D-14 (1 adult), D-23 (1 adult). Station 144: D-4 (6 adults).

Family Ophiochitonidae.

Ophionereis annulata (Le Conte).

Ophiolepis annulata Le Conte, 1851, p. 317.

Ophionereis annulata, Lyman, 1860, p. 203; Nielsen, 1932, p. 309.

Type: Cat. No. 1584, M. C. Z.

Type Locality: West coast of Panama.

General Range: From San Diego, California, to Panama and the Galápagos Islands; Clarion Island. From shore to 20 fathoms.

Local Distribution: Two young specimens were taken off Clarion Island (Station 163: D-1) at a depth of 20 fathoms on a bottom formed of coral and rock.

Remarks: The disk diameters of the specimens are 5 mm. and 4 mm. respectively. The color (dried) is much lighter than that of the types. The disk and arms are pale bluff, the latter banded with brown every fourth or fifth segment.

Ophionereis eurybrachiplax H. L. Clark.

Ophionereis eurybrachiplax H. L. Clark, 1911, p. 173.

Ophionereis eurybrachiplax, Nielsen, 1932, p. 309.

Type: Cat. No. 25589, U. S. N. M. (paratypes Cat. Nos. 3175, 3176, M. C. Z.)

Type Locality: Off California.

General Range: From Central California to Lower California. From 27 to 45 fathoms.

Local Distribution: Two specimens were taken west of San José Point (Station 175: D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: Upon comparison these specimens proved to be almost identical with the types. Their disk diameters are 15 mm. and 20 mm. respectively. The arms are broken but they were about 120 mm. long. The color of the dried specimens is brown; the distal portion of the arms has a light gray median line and lateral markings dorsally.

These specimens extend the known range of the species more than 200 miles to the south along the Pacific coast.

Family Ophiocomidae.

Ophiocoma aethiops Lütken.

Ophiocoma aethiops Lütken, 1859, p. 145.

Ophiocoma aethiops, Nielsen, 1932, p. 246.

Type: Probably in Copenhagen.

Type Locality: West coast of Panama.

General Range: From Lower California to Panama and the Galápagos Islands; Gulf of California (Arena Bank); Clarion Island.

Local Distribution: A total of nine specimens was taken off Arena Bank at 2½ fathoms in coral (*Pocillopora ligulata*) and in tide pools on Clarion Island.

Remarks: The largest specimen has a disk diameter of 30 mm.; the smallest disk diameter is 13 mm. The color of the dried specimens is black; only the largest specimen has a gray center, 15 mm. in diameter, on the dorsal side.

Material: Station 136: D-33 (8 broken adults). Tide pools, Clarion Island: (1 adult).

Ophiocoma alexandri Lyman.

Ophiocoma alexandri Lyman, 1860, p. 256.
Ophiocoma alexandri, Nielsen, 1932, p. 248.

Type: Cat. No. 1825, M. C. Z. (holotype).

Type Locality: Acapulco, Mexico.

General Range: From Lower California to Panama and the Galápagos Islands; Clarion Island. From shore to 5 fathoms.

Local Distribution: One adult from tide pools, Clarion Island.

Remarks: The diameter of the disk is 16 mm., length of arms about 100 mm. The dried specimen is brown with alternating light and dark brown arm bands every few segments.

Family Ophiodermatidae.

Ophioderma panamense Lütken.

Ophioderma panamense Lütken, 1859, p. 91.
Ophioderma panamense, Nielsen, 1932, p. 327.

Type: Probably in Copenhagen.

Type Locality: West coast of Panama.

General Range: From San Pedro, California, to Payta, Peru, and the Galápagos Islands. From shore to 10 fathoms.

Local Distribution: One broken specimen was taken from the shore of Santa Inez Bay.

Remarks: In this dried specimen, the 19 mm. disk is brown and the arms are slate brown.

Ophioderma variegatum Lütken.

Ophioderma variegatum Lütken, 1856, p. 21.
Ophioderma variegatum, Nielsen, 1932, p. 350.

Type: Probably in Copenhagen.

Type Locality: Realejo, Nicaragua (west coast).

General Range: From San Diego, California, to Panama, also at Clarion Island. From shore to 60 fathoms.

Local Distribution: A total of 11 specimens was taken from Gorda Banks, Arena Bank, Santa Inez Bay and Clarion Island from shore to 60 fathoms on muddy, sandy and rocky bottoms.

Remarks: This series ranges from 7 mm. in diameter to 15 mm.; the arms of the largest specimen are about 55 mm. long. One specimen has only four rays. The common color combination is a red disk dorsally with green, white and narrow black bands on the arms. The oral surface is light cream color, almost white. Two smaller specimens have mottled white and brown disks; the arms are banded, brown and brown with white speckles. In life these specimens were probably more highly colored.

Material: Station 136: D-24 (4 adults), D-26 (3 adults). Station 142: D-1 (2 adults). Station 150: D-18 (1 young). Tide-pools, Clarion Island (1 adult).

Schizoderma diplax Nielsen.

Schizoderma diplax Nielsen, 1932, p. 335.

Type: Copenhagen.

Type Locality: Perlas Island, Gulf of Panama.

General Range: From Lower California to Panama. From shore to 60 fathoms.

Local Distribution: A total of 20 specimens was taken from Arena Bank, Gorda Banks and Santa Inez Bay between 29 and 60 fathoms, usually on muddy, rarely on sandy, bottoms.

Remarks: This fine series ranges from 7 mm. to 15 mm. in disk diameter. The color (dried) is light brown with dark brown and gray markings on the disk; the arms are gray with brown bands every two to four segments. This series extends the known range of the species more than 2,000 miles to the north, the first record from the Gulf of California.

Material: Station 136: D-1 (1 adult), D-14 (1 adult). Station 142: D-1 (3 adults), D-2 (2 adults), D-3 (1 adult), D-4 (2 adults). Station 143: D-1 (3 adults). Station 150: D-8 (5 adults), D-9 (2 adults).

Diopederma danianum (Verrill).

Ophiura danianum Verrill, 1867a, p. 254.

Diopederma danianum, H. L. Clark, 1913, p. 206; Nielsen, 1932, p. 339.

Type: Peabody Museum, New Haven.

Type Locality: La Union, Salvador (west coast).

General Range: Lower California to Salvador, and the Perlas Islands, Gulf of Panama. From 3 to 25 fathoms.

Local Distribution: One adult was taken in San Lucas Bay (Station 135: D-20) at a depth of 3 fathoms on a sandy bottom.

Remarks: This individual has a disk diameter of 11 mm. The arms are about 33 mm. long. The color of the disk is gray with white and brown markings; the arms are light gray with brown transverse bands every two to three arm segments; the ventral surface is white.

Ophiuroconis bispinosa sp. nov.

(Text-figure 2).

Diagnosis: Rays five; disk covered dorsally and ventrally with fine granulations; two hyaline arm-spines, three or four oral papillae, tentacle-scale single, scoop-shaped, large, longer than upper arm-plates near the arm-tips.

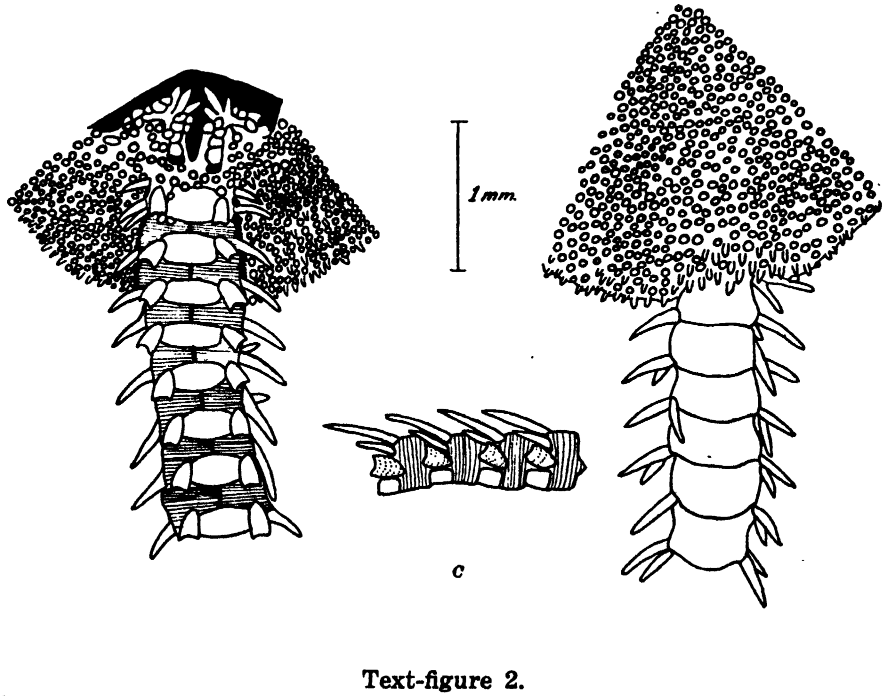
Description: Disk 3 mm. in diameter; arms 17 mm. long. Disk circular, thick; radial shields depressed; entire dorsal surface covered with a fine granulation becoming heavier and longer at the margins and over the radial shields. Arms long and slender. Basal upper arm-plates quadrangular, broader than long, distal margins wider than proximal, slightly convex; lateral margins nearly straight; plates broadly in contact throughout, but distally twice as long as wide with distal margin convex and lateral slightly concave.

Interbrachial areas below heavily granulated distally, more sparsely proximally. Genital slits large, but genital plates concealed. Oral shields, mouth shields and proximal ventral arm-plates covered but not concealed by scattered coarse granules; these may occur as far as the distal margin of the fourth under arm-plate. Oral shields triangular with an acute proximal point and concave sides; distal margin smoothly rounded. Adoral plates narrow

and long, about three times as long as wide, acutely pointed proximally and barely meeting within. Oral plates much larger than adorals and covered with granules.

Oral papillae three on each side or possibly four; owing to the granules on the oral plates which are irregular in size, form and position, and to the size and position of the oral tentacles, with accompanying scales, it is difficult if not impossible to be sure how many oral papillae there are. If each oral tentacle is assigned a scale, there are only three papillae on each side, but the large nearly circular scale associated with the second tentacle has the position and relationship of a distal oral papilla and may be considered as such. In that case, there are four oral papillae on each side, the distalmost much the longest; proximal long, slender, acute, pointing toward the mouth; second scale-like, blunt. Tentacle-scale single, relatively very large and of usual form; longer than wide, truncate, markedly convex parallel to its long axis, it resembles a small scoop; distally, it is increasingly longer and narrower so that near the tip of the arm it is two or even three times as long as wide, greatly exceeding the under arm-plates and finally becoming equal to the whole arm-segment. The scales are translucent, concentrically striated.

First under arm-plate well covered with granules; second shield-shaped, hexagonal, with a short straight proximal margin, at each end of which is a markedly concave side, connecting it with the slightly convex lateral margins, which merge in a convex distal end; third and succeeding plates wider than long, with proximal and distal margins slightly convex, and lateral margins slightly concave; distally the plates become quadrangular and widely separated by the side arm-plates. The latter are large, concentrically striated, not meeting above, but fully in contact below; each plate carries on its distal margin two tapering, but not very acute hyaline spines, the



Text-figure 2.
Ophiuroconis bispinosa sp. nov. **A**, oral side; **B**, aboral side; **C**, ventro-lateral view of arm showing spines and tentacle-scale.

upper being the longer, about the length of an arm segment, or distally a trifle more. The union of the side arm-plates below forms a slight ridge, which extends to the arm-tip.

The color dried from alcohol is as follows: disk cream color with irregular light brown markings over the radial shields. Arms light tan with bands of brown or black, two to four segments wide (usually two), alternating with a light colored area; near disk, the light and dark bands are four segments wide, but distally they are only half as wide. Lower surface white, with some under arm-plates (usually in pairs) faintly dusky.

Type: Cat No. 5422, M. C. Z.

Material: One juvenile (the holotype) from San Lucas Bay (Station 135: D-20) at a depth of 3 fathoms on a sandy bottom.

Remarks: According to Matsumoto's classification this specimen belongs to *Ophiuroconis*, although it is not typical. Additional material may prove it to be the young of some known species, but in view of its striking peculiarities this seems highly improbable. Compared with specimens of young *Ophioderma*, it is decidedly not the young of any member of that genus.

Family Ophiolepididae.

Ophiura lütkeni (Lyman).

Ophioglypha lütkeni Lyman, 1860, p. 197.

Ophiura lütkeni, McClendon, 1909, p. 37; Nielsen, 1932, p. 316.

Type: Cat. No. 1039, U. S. N. M.

Type Locality: Puget Sound, Washington.

General Range: From Alaska to Lower California. From 15 to 100 fathoms.

Local Distribution: 1,844 young individuals were taken east of Cedros Island (Station 125: D-1) at a depth of 44 fathoms on a muddy bottom. In addition, several bushelsful taken in the same net, were thrown overboard.

Remarks: The range in size of these specimens is from 2 mm. to 7 mm. disk diameter. The color (dried) is gray dorsally. In most specimens the disk has one or more white spots; if one, it is usually located in the center. The armspines and oral surface are white.

This record extends the known range south to Lower California.

Ophiolepis crassa Nielsen.

Ophiolepis crassa Nielsen, 1932, p. 324.

Type: Copenhagen.

Type Locality: Gulf of Panama.

General Range: From the Gulf of California to Panama. From 4 to 75 fathoms.

Local Distribution: A total of 35 specimens was taken off Cape San Lucas, on Gorda Banks, on Arena Bank and in Santa Inez Bay between 40 and 75 fathoms on muddy, sandy and rocky bottoms.

Remarks: This series ranges from 6 mm. to 15 mm. in disk diameter. The color of the dried specimens is tan with light and dark mottlings, the arms light tan with broad brown bands on every third segment; the short arm-spines are light in color; color in life similar.

These are the first specimens of *crassa* to be recorded from the Gulf of California; the known range is thus extended about 2,000 miles to the north.

Material: Station 136: D-1 (1 adult), D-23 (3 adults), D-24 (6 adults), D-26 (5 adults). Station 150: D-8 (2 adults), D-16 (6 adults), D-18 (9 broken adults). Station 151: D-1 (2 adults). Station 142: D-1 (1 adult).

Class Echinoidea.

Family Cidaridae.

Eucidaris thouarsii (Agassiz & Desor).

Cidaris thouarsii L. Agassiz & Desor, 1846, p. 326.

Eucidaris thouarsii, Mortensen, 1928, p. 393.

Type: Unknown.

Type Locality: Unknown.

General Range: Lower California to Panama and the Galápagos Islands. From shore to 50 fathoms.

Local Distribution: A total of 17 specimens was taken from Arena Bank and Clarion Island between shore and 50 fathoms on muddy bottoms, in coral (*Pocillopora ligulata*) and in a tide-pool.

Remarks: This species is common in the Panamic region, but the young are usually well concealed in coral heads. It has not been previously recorded below 20 fathoms. The present series ranges from 7 mm. to 38 mm. in diameter. Color of dried adults: test almost black, spines purple usually covered with white bryozoan colonies. Young: test reddish-brown, spines red with one to five white bands.

Material: Station 136: D-1 (4 young), D-12 (2 young), D-23 (2 young), D-24 (5 young), D-26 (2 young), D-33 (1 adult). Clarion Island tide-pool: (1 adult).

Hesperocidaris perplexa (H. L. Clark).

Tretocidaris perplexa H. L. Clark, 1907, p. 205.

Hesperocidaris perplexa, Mortensen, 1928, p. 421.

Type: Cat. No. 188, M. C. Z.

Type Locality: Gulf of California.

General Range: Gulf of California and Clarion Island. From 30 to 80 fathoms.

Local Distribution: A total of 12 specimens was taken on Gorda Banks, Arena Bank and in Santa Inez Bay between 40 and 80 fathoms on muddy and sandy bottoms.

Remarks: This series is well graduated in size from 11 mm. to 52 mm. in diameter. Color of the dried test, green with purple secondary spines and dull green, pink-tipped primary spines.

Material: Station 136: D-1 (1 adult), D-7 (1 adult), D-17 (2 adults). Station 142: D-4 (1 adult). Station 150: D-2 (4 young), D-13 (1 young), D-18 (2 young).

Family Centrechinidae.

Centrechinus mexicanus (A. Agassiz).

Diadema mexicanum A. Agassiz, 1863, p. 20.

Diadema mexicanum, H. L. Clark, 1902, p. 526.

Centrechinus mexicanus, H. L. Clark, 1921. Echinoderm Fauna of Torres Strait, p. 145.

Type: Cat. No. 635, M. C. Z. (cotypes).

Type Locality: Acapulco, Mexico.

General Range: From Puget Sound to Panama and the Galápagos Islands. From shore to 20 fathoms.

Local Distribution: A total of seven specimens was taken from Clarion Island (Station 163: D-1, 6 young; Sulphur Bay, 1 adult) between 2 and 20 fathoms in rocks and coral.

Remarks: These specimens consist of six young and one adult which has a diameter of only 27 mm., while the longest spine is 68 mm. The spines are dark in color, lacking the alternate bands of white found on younger specimens.

Of all the animals encountered in pearl diving, the divers fear this echinoderm most. The spines, which are easily broken when in contact with the body, are covered with a poisonous mucous and being exceedingly sharp penetrate human skin easily. There the tips break off at once and, being retrorsely barbed, it is nearly impossible to remove them; they are, however, rapidly absorbed by healthy tissue. The poison is a bad irritant, but the quantity borne by any one spine is so small that serious results occur only when a great number penetrate at one time; yet the wound caused by one is extremely painful. To add to the hazard the animal is sensitive to light and the passing of a shadow will cause it to project the spines from its well concealed hiding place in coral and rock formations. The present writer has been stung several times when collecting echinoderms. The injured finger soon became inflamed, swollen and discolored. A smarting, burning sensation remained in the finger for more than half an hour, accompanied by a nauseated feeling in the stomach.

Centrostephanus coronatus (Verrill).

Echinodiadema coronata Verrill, 1867a, p. 294.

Centrostephanus coronatus, A. Agassiz, 1872, p. 97; H. L. Clark, 1923, p. 158.

Type: Probably in the Peabody Museum, New Haven.

Type Locality: Cape San Lucas, Lower California.

General Range: From Santa Catalina Island, California, to Cape San Lucas. From shore to 34 fathoms.

Local Distribution: One specimen was taken on Arena Bank (Station 136: D-5) at a depth of 34 fathoms on a sandy bottom with abundant weed.

Remarks: Test 7 mm. high; diameter 17 mm.; longest spine 33 mm. Color in alcohol, test purple, secondary spines light yellow and pinkish, primary spines white with purple alternating bands. In life all spines were banded with maroon and buff. The spines are brittle, often breaking at the slightest pressure, and are covered with crowded whorls of minute prickles.

Family Arbaciidae.

Arbacia incisa (A. Agassiz).

Echinocidaris incisa A. Agassiz, 1863, p. 20.

Arbacia incisa, H. L. Clark, 1913, p. 220.

Type: Cat. No. 467, M. C. Z. (cotype).

Type Locality: Guaymas, Mexico.

General Range: From Magdalena Bay, Lower California, to Zorritos, Peru; Gulf of California; Galápagos Islands. From shore to 29 fathoms.

Local Distribution: A total of six specimens was taken from Arena Bank and Santa Inez Bay between shore and 29 fathoms on sandy and muddy bottoms and in coral (*Pocillopora ligulata*).

Remarks: This is a common species on the west coast of America. The series ranges in size from 6 to 18 mm. in diameter. The color is purple to black; one specimen is gray with purple central markings and light purple spines.

Material: Station 141: D-1 (2 young), D-2 (1 adult). Station 143: D-1 (1 young). Santa Inez shore: (1 young). Station 136: D-33 (1 young).

Family Echinidae.

Lyctechinus anamesus H. L. Clark.

Lyctechinus anamesus H. L. Clark, 1912, p. 254.

Type: Cat. No. 3916, M. C. Z. (cotype).

Type Locality: Off San Diego, California, *Albatross* Station 2930, 60 fathoms.

General Range: From Santa Barbara, California, to Point San Bartolome Bay, Lower California, and Guadeloupe Island. From 30 to 60 fathoms.

Local Distribution: A total of 24 specimens was taken east of Cedros Island off San José Point, Lower California, between 38 and 45 fathoms on muddy and shaley bottoms.

Remarks: A very interesting series, ranging in diameter from 10 to 21 mm. Dried from alcohol the spines are light yellowish green, the test gray with a purplish tinge in the interambulacra. In life the specimens were entirely white.

Material: Station 126: D-2 (1 young, 1 test), D-3 (2 adults). Station 127: D-1 (9 adults). Station 175: D-1 (11 adults).

Tripneustes depressus A. Agassiz.

Tripneustes depressus A. Agassiz, 1863, p. 24.

Tripneustes depressus, H. L. Clark, 1912, p. 285.

Type: Unknown.

Type Locality: Guaymas, Mexico.

General Range: Gulf of California, Socorro, Clarion and the Galápagos Islands. From shore to 40 fathoms.

Local Distribution: One adult specimen was taken from Clarion Island in the tide-pools west of the landing.

Remarks: This specimen has a H. D. of 86 mm. and a V. D. of 46 mm. The test is purple, covered with short white spines.

Family Strongylocentrotidae.

Strongylocentrotus fragilis Jackson.

Strongylocentrotus fragilis Jackson, 1912, p. 128.

Strongylocentrotus fragilis, H. L. Clark, 1912, p. 354, pl. 113, figs. 3-6.

Type: Cat. No. 3668, M. C. Z.

Type Locality: Catalina Island, California.

General Range: From Oregon to northern Lower California. From 45 to 638 fathoms.

Local Distribution: One young specimen was taken west of San José Point (Station 175: D-1) at a depth of 45 fathoms on a shaley bottom.

Remarks: There is only a single specimen at hand and this is but 9 mm. in diameter. The test is reddish, the spines red with white tips. This species has an exceedingly fragile test which is easily crushed in dredging. The known range is extended south into Mexico by this specimen.

Family Echinometridae.

Echinometra oblonga de Blainville.

Echinus oblonga de Blainville, 1825, p. 95.

Echinometra oblongus, de Blainville, 1830, p. 206; H. L. Clark, 1912, p. 373.

Type: Unknown.

Type Locality: Unknown.

General Range: Hawaiian, Paumotus and Gilbert Islands and westward to Mauritius; also Clarion Island. From shore to 7 fathoms.

Local Distribution: Two adults and one young were taken from Sulphur Bay, Clarion Island, in coral (*Pocillopora*) at a depth of 2 fathoms.

Remarks: The smallest specimen is 9 mm. high and 17 mm. long, the largest 28 mm. high and 61 mm. long. The spines are short, blunt and almost black in color; the test is dark purple. These individuals do not differ essentially from other specimens previously taken at Clarion Island.

Family Clypeastridae.

Clypeaster speciosus Verrill.

Clypeaster speciosus Verrill, 1870, p. 95.

Clypeaster speciosus, H. L. Clark, 1914, p. 31.

Type: Cat. No. 2203, M. C. Z. (cotype).

Type Locality: La Paz, Lower California.

General Range: Gulf of California and the Galápagos Islands. From shore to 10 fathoms.

Local Distribution: One adult and a dead bleached test were taken from Santa Inez Point, Santa Inez Bay.

Remarks: The adult is 77 mm. in length, 68 mm. in width and 18 mm. in height. The color of the dried specimen is dark purple, almost black. The bleached test devoid of spines is 51 mm. in length, 44 mm. in width, 13 mm. in height.

Clypeaster europacificus H. L. Clark.

Clypeaster europacificus H. L. Clark, 1914, p. 27.

Types: Cat. Nos. 4179, 4180, M. C. Z.

Type Localities: Gulf of California and Gulf of Panama.

General Range: Gulf of California to Gulf of Panama, Clarion Island and Galápagos Islands. From 7 to 50 fathoms.

Local Distribution: A total of six specimens was taken from Arena Bank and Santa Inez Bay between 29 and 50 fathoms on sandy and muddy bottoms.

Remarks: The smallest specimens measure 29, 34, 53 and 54 mm. in length; the larger ones 163 and 166 mm. The larger specimens, dull green

in life, are greenish brown when dried; the smaller have a purplish tinge, although the spines are green.

Material: Station 136: D-1 (1 adult), D-26 (1 young). Station 142: D-4 (1 adult). Station 143: D-1 (3 young).

Family Scutellidae.

Encope grandis L. Agassiz.

Encope grandis L. Agassiz, 1841, p. 57.
Encope grandis, H. L. Clark, 1914, p. 75.

Type: Unknown.

Type Locality: Gulf of California. From shore to 10 fathoms.

Local Distribution: One young specimen was taken in San Lucas Bay (Station 135: D-20) at a depth of three fathoms on a sandy bottom, and two bleached tests from Santa Inez Point, Santa Inez Bay.

Remarks: The tests are 76 and 94 mm. in length. The larger specimen had evidently been dead for some time as the surface of the test is scarred by worms. The smaller test is well preserved. The very young specimen, which is probably *grandis,* measures 22 mm. in length and 23 mm. in width. It corresponds well with other small specimens in the M. C. Z. collection.

Encope micropora L. Agassiz.

Encope micropora L. Agassiz, 1841, p. 50.
Encope micropora, H. L. Clark, 1914, p. 74.

Type: Unknown.

Type Locality: Apparently the Galápagos Islands.

General Range: From Lower California to the Bay of Sechura, Peru, and the Galápagos Islands. From shore to 45 fathoms.

Local Distribution: One adult specimen was taken on Arena Bank (Station 136: D-1) at a depth of 45 fathoms on a muddy bottom.

Remarks: This specimen measures 100 mm. in width and 91 mm. in length. The margin of the test is irregular, having been bitten off or broken. The color of the dried individual is a light mouse gray.

Family Spatangidae.

Brissopsis pacifica (A. Agassiz).

Toxobrissus pacificus A. Agassiz, 1898, p. 82.
Brissopsis pacifica, Mortensen, 1907, p. 44; H. L. Clark, 1914, p. 203.

Type: Cat. No. 3063, M. C. Z.

Type Locality: Off Panama, 7° 12′ 20″ N. Lat., 80° 55′ W. Long. 182 fathoms.

General Range: Southern California to Panama. From 38 to 284 fathoms.

Local Distribution: A total of five specimens was taken east of Cedros Island, and off San José Point, Lower California, between 38 and 56 fathoms on muddy and shaley bottoms.

Remarks: Two of the specimens are badly crushed. The smallest individual is 16 mm. long, 13 mm. wide and 9 mm. high; the largest is 51 mm.

long, 42 mm. wide and 25 mm. high. The color in life was white; in alcohol it is light brown, the peripetalous fasciole is almost black; dried specimens are of a greenish-brown tinge.

Material: Station 126: D-6 (1 young, 1 adult), D-9 (fragments of an adult). Station 127: D-1 (fragments of an adult). Station 175: D-1 (1 young).

Meoma grandis Gray.

Meoma grandis Gray, 1851, p. 132.

Meoma grandis, H. L. Clark, 1917, p. 220.

Type: Probably in the British Museum.

Type Locality: "Australia" (Captain E. D. Belcher). Probably the west coast of tropical America.

General Range: Gulf of California and the west coast of Mexico. From 20 to 60 fathoms.

Local Distribution: Two specimens and fragments of another were taken on Arena Bank, Gorda Banks and in Santa Inez Bay, between 40 and 60 fathoms on muddy bottoms.

Remarks: The larger specimen has a length of 100 mm., width of 92 mm. and height of 47 mm. The smaller specimen is 90 mm. long, 82 mm. wide and 40 mm. high. The color of the dried specimens is brown with a purplish tinge, spines greenish-brown, tips of spines yellow.

Material: Station 136: D-23 (1 adult). Station 141: D-4 (1 adult). Station 150: D-18 (fragments of an adult).

Lovenia cordiformis A. Agassiz.

Lovenia cordiformis A. Agassiz, 1872, p. 57.

Lovenia cordiformis, H. L. Clark, 1917, p. 254.

Type: Cat. No. 3188, M. C. Z. (cotype).

Type Locality: Guaymas, Mexico.

General Range: From Santa Barbara, California, to Guayaquil, Ecuador, Galápagos Islands and Hawaiian Islands. From 8 to 54 fathoms.

Local Distribution: A total of five specimens was taken east of Cedros Island and in Santa Inez Bay between 25 and 40 fathoms on muddy and sandy-mud bottoms.

Remarks: This interesting series contains four young, the smallest being 16 mm. in length, 11 mm. in width and 8 mm. in height. The largest specimen is 39 mm. long, 30 mm. wide and 16 mm. high. In life the specimens ranged from grayish-green to white. The color of the dried material is gray, the large spines purplish. There are indubitable specimens of this species in the M. C. Z. from Maui, Hawaiian Islands.[3]

Material: Station 126: D-3 (1 adult). Station 143: D-4 (4 young).

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[3] Not yet recorded in the literature, as far as I am aware.

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16.

The Templeton Crocker Expedition. XI. Hermit Crabs from the Gulf of California and the West Coast of Lower California.[1]

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[Note: This is the eleventh of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica*, No. 2, pp. 33 to 46.]

CONTENTS.

[1] Contribution No. 531, Department of Tropical Research, New York Zoological Society.

INTRODUCTION.

This collection of pagurids from the Gulf of California comprises 26 species in 9 genera. 8 new species are described, and 5 new combinations are noted. New locality records are given, some extending the known range nearly 20 degrees of North latitude. The type specimens for all the new species are deposited in the New York Zoological Society.

I wish to express my thanks to Dr. Knud Stephensen, of the Zoologisk Museum, Copenhagen, and Dr. Bruno Parisi, of the Museo Civico di Storia Naturale, Milan, for literature, and to Dr. Waldo L. Schmitt, of the U. S. National Museum, for the loan of comparative specimens, and photographs of some unpublished drawings in that institution. I wish also to acknowledge my indebtedness to the California Academy of Sciences in San Francisco, for the loan of material.

Family COENOBITIDAE.

Genus *Coenobita* Latreille.

Coenobita compressus (Guérin).

Coenobita compressa Guérin. Voy. autour du Monde sur la *Coquille* par Duperrey, *Zool.*, vol. 2, pt. 2, 1831, p. 29.

Coenobita compressus Faxon. *Mem. Mus. Comp. Zool.*, vol. 18, 1895, p. 52; Rathbun, *Proc. U. S. Nat. Mus.*, vol. 38, 1910, p. 596; Schmitt, *Zoologica*: N. Y. Zool. Soc., vol. 5, no. 15, 1924, p. 170; Boone, *Zoologica*: N. Y. Zool. Soc., vol. 14, no. 1, 1931, p. 25, fig. 7.

General Range: East Africa to Pacific shores of America.

Local Distribution: A single male specimen was taken at San Lucas Bay, inside Cape San Lucas, Baja California, Mexico (Station 135).

Sex and Size: This male specimen has the following dimensions: length from rostrum to telson 57 mm., of carapace 17 mm., of precervical portion of carapace 9 mm., width 6 mm., length of cheliped 28 mm., of merus 9 mm., of carpus 7 mm., of manus 10.5 mm., of dactyl 6 mm., width of manus 9.5 mm., length of eye-stalk 5.0 mm.

Color: In alcohol, carapace a cream; chelipeds and ambulatories a taupe; hands a brownish-yellow.

Habitat: For the most part these terrestrial hermit crabs inhabit the land bordering on the sea. They select heavy shells for their abode. They are, in the main, vegetarians, though they do not limit their diet and may at times act as scavengers, or become carnivorous. In the author's experience, they seem to have a strongly developed sense of smell, as they immediately gathered in large numbers on fresh burro droppings. They also proved a nuisance to the mammalogist in our party, who baited his traps with rolled oats. In addition they are good tree climbers.

Remarks: This is a widely distributed and variable species. Its range does not extend to the head of the Gulf of California.

Family PAGURIDAE.

Genus *Paguristes* Dana.

Key to species of Paguristes *collected on this expedition.*

A. Hands broad, 1/5 longer than wide. Antennal flagellum reaching hand.
- B. Chelipeds without heavy spines except on inner margins; carpus with 3, manus with 6 or 7. Flagellum nearly naked. *P. digueti.*
- B′. Chelipeds with heavy spines on upper surface and inner margins; carpus with 6, manus with 4. Flagellum lightly ciliated. *P. bakeri.*

A′. Hands twice or nearly twice as long as wide. Antennal flagellum reaching hand. Chelipeds spinulose.
- B. Flagellum heavily ciliated beneath. Hands more than twice as long as wide. Inner margin of carpus with 4 spines; manus with 3 spines. *P. occator.*
  - C. Hands twice as long as wide. Inner margin of carpus with 6 spines; manus with 5 spines. *P. praedator.*
- B′. Flagellum lightly ciliated. Inner margin of carpus with 5 spines; manus with 4 spines.
  - C. Rostral tooth short, equal in length to laterals. Hands 2/3 as wide as long. *P. holmesi.*
  - C′. Rostral tooth long, exceeding the length of laterals. Hands almost twice as long as wide. *P. oculiviolaceus.*

A″. Hands twice as long as wide. Antennal flagellum short, not reaching hand; lightly ciliated. Inner margin of carpus with 4 spines; manus with 3 spines. *P. aztatlanensis.*

Paguristes digueti Bouvier.

Paguristes digueti Bouvier. *Bull. Soc. Philom.*, Paris, vol. 8, no. 5, 1892-93, p. 18, figs. 1-4 (type-locality, Santa Rosalia, Baja California).

General Range: So far only recorded from the Gulf of California.

Local Distribution: A total of 5 specimens was taken from Arena Bank (Station 136), and Santa Inez Bay (Stations 141 and 143), between 7 and 33 fathoms.

The specimens were distributed as follows:

Station 136: D-5 (2 juvenile females); 33 fathoms.
Station 141: D-1 (1 male); 7 to 9 fathoms.
Station 143: D-1 (2 males); 29 fathoms.

Sex and Size: The collection numbers 3 adult males and 2 juvenile females. The largest specimen, a male from Station 141 D-1, has the follow-

ing measurements: length from rostrum to telson 80 mm., of carapace 20 mm., of precervical portion of carapace 11 mm., width of same 11 mm., length of cheliped 34 mm., of merus 10 mm., of carpus 7 mm., of manus 14 mm., of dactyl 10 mm., width of manus 11 mm., length of eye-stalk 9 mm.

Color: In alcohol, a pinkish-white, maculated with a rich red; hands a darker red. Cornea of eyes blue, on red stalks.

Habits, Habitat: This species usually occupies a shell with a narrow aperture, such as *Strombus*, which gives a distorted shape to the carapace, greatly distending the branchial regions. It is evidently not an inter-tidal form, but may be expected in depths ranging from 10 to 50 fathoms.

Remarks: These are new locality records for this species, extending the geographical range more than 4 degrees of latitude to the south.

Paguristes bakeri Holmes.

Paguristes bakeri Holmes. *Occas. Papers Calif. Acad. Sci.*, vol. 7, 1900, p. 152 (type-locality, San Diego, California); Rathbun, *Harriman Alaska Expedition,* vol. 10, 1910, p. 162; Hilton, *Jour. Ent. Zool.*, Pomona Coll., vol. 8, no. 2, 1916, p. 65, figs. 11-12; Schmitt, *Univ. Cal. Pub. Zool.*, vol. 23, 1921, p. 124, pl. 18, figs. 2-6.

General Range: From San Francisco to San Diego, California, and the Gulf of California, to a depth of 116 fathoms. (Schmitt).

Local Distribution: A total of 7 specimens was taken east of Cedros Island (Station 128 D-1), at 39 fathoms; 1 male was taken east of Cedros Island (Station 126 D-3), at 40 fathoms.

Sex and Size: The series collected at both stations consists of 7 males and 1 female, all adults. A large male from Station 128 has the following measurements: length from rostrum to telson 90 mm., of carapace 26 mm., of precervical portion of carapace 14 mm., width of same 12 mm., length of cheliped 45 mm., of merus 14 mm., of carpus 12 mm., of manus 17 mm., of dactyl 9 mm., width of dactyl 13.5 mm., length of eye-stalk 11 mm.

Color: In alcohol, carapace a pinkish-white overlaid with an orange red. Eye-stalks red. Chelipeds and ambulatories a buff. Spines a corneous brown. Setae a straw yellow.

Habits, Habitat: This large, active pagurid occupies a heavy shell. In the shallower waters along the California coast it usually occupies the discarded shell of *Polinices lewisii* (Gould), or some such durable gastropod shell. When occuping the *Polinices* shell it is invariably accompanied by a polynoid worm, which seeks seclusion in the umbilicus.

Remarks: These more southern forms differ in no wise from those taken in more northern waters, and are similar in form, color and size, to those found off the California coast.

Paguristes occator, sp. nov.

Type: Male, holotype; Cat. No. 361,119, Department of Tropical Research of the New York Zoological Society; Station 150, Dredge 2; from the Gulf of California, 23° 01′ N. Lat., 109° 28′ W. Long., off Gorda Point, Lower California, Mexico; 75 fathoms; bottom sandy; April 21, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca.*

Diagnosis: Median tooth extending past laterals and past the proximal end of eye-scales. Eye-stalks long, slender, and slightly curved outward. Chelipeds spinulose, margins subparallel; width and thickness of hands subequal. Flagellum of antennae heavily ciliated beneath, nearly nude on upper surface.

Description: Anterior portion of carapace slightly longer than wide; rostral tooth triangular, equilateral, sharp-pointed, extending past laterals and between the bases of the eye-stalks; laterals obtuse, armed with a minute, marginal spinule; surface punctate, with a few tufts of setae.

Eye-stalks long, slender and slightly curved outward; in length they equal the width of the carapace, and extend nearly as far as the distal end of the merus. Ophthalmic scales broad at base, inner margin entire, curving downward, tip triangular, trifid, with a prominent, conical spine, two lesser spines on outer margin.

Antennal acicle extends 3/5 the length of the eye-stalk; including spines, it is 1½ times longer than wide; six prominent, sharp, corneous-tipped spines on inner margin; two similar spines on outer distal margin, with basal margins of spines supporting tufts of long, pinnate-tipped setae. Distal end of 3rd peduncle of antennae does not reach cornea of eye; flagellum, heavy ciliated on under side, sparsely on upper surface, reaches past proximal end of hands.

The chelipeds are subequal, similar, spinulose, with tufts of pinnate-tipped setae originating at the anterior base of spines; merus trigonal, upper edge granular, distal and subdistal margins armed with a lateral row of spines; lower margins spinulose, the outer with short, the inner with 6 or 7 longer and more prominent spines increasing in length and size, distally; the carpus is short, ¼ longer than wide, armed on inner margin with 4 upward- and forward-pointing corneous spines inside of which, on upper surface, is a row of smaller intermediate spines, while outer margin has a row of small spines; hands are long, narrow and thick, subequal, similar; width, subequal to thickness; 3 long, corneous-tipped spines on inner margin of palm; row of spines on outer margin of hand, the largest on pollex; few scattered similar spines on upper surface of hand and fingers; dactyl is subequal in length to carpus; pollices subequal in width to their dactyli, with tips corneous, acuminate; teeth are calcareous lobes.

The ambulatory legs slightly exceed the chelipeds in length, margined with setae; upper carpal and propodal crest of 1st pair, spinulose, of 2nd pair, rugose.

Color: In alcohol, a light pinkish tint, iridescent. Chelipeds splotched with pink and white. Dactyli of ambulatory legs banded with white. Setae a straw yellow.

Measurements: Male, holotype; length from rostrum to telson 36 mm., of anterior portion of carapace 6 mm., width 5 mm., length of cheliped 14.8 mm., of merus 5.7 mm., of carpus 4 mm., of manus 7 mm., of dactyl 4 mm., thickness of hand 3 mm., width 3 mm., length of eye-stalk 5 mm., of antennal acicle 2.5 mm., width 1 mm.

Range: Known only from type locality.

Material Examined: The holotype male (see *Type*).

Remarks: This proposed species is allied to *P. turgidus* (Stimpson), 1857, but differs in that the hands are twice as long as wide, instead of one-third, or more, longer than wide, by the eye-stalks being as long as the width of the carapace, instead of three-fourths as long as the width of the carapace, by the antennal flagellum being densely ciliated below, instead of sparsely haired, by the inner margin of the hand being armed with 3 spines, instead of armed with 4. It is also allied to *P. ulreyi* Schmitt, 1921, but differs in the shape and size of the hand, being straighter and narrower, and by there being fewer spines on the chelipeds.

Paguristes praedator, sp. nov.

Type: Male, holotype; Cat. No. 36,782, Department of Tropical Research of the New York Zoological Society; Station 136, Dredge 27; from the Gulf

of California, 23° 28′ N. Lat., 109° 24′ W. Long., 3 miles northeast of Cape Pulmo, Lower California, Mexico; 50 fathoms; bottom sandy with rock; May 1, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca.*

Diagnosis: Median tooth of carapace not extending past laterals, nor reaching base of eye-scales. Eye-stalks long, slender, straight. Chelipeds spined on inner margin; carpus with 6; manus with 5. Antennal flagellum heavily ciliated beneath.

Description: Anterior portion of carapace but slightly longer than wide, surface with few setae; median tooth subtruncate, short, not extending to the base of eye-scales, upper surface concave; lateral projections obtuse, extending past the median and tipped with a small marginal spine. The posterior margin of the carapace is but slightly concave.

Eye-stalks long, slender, slightly constricted in the middle, in length they are subequal to the length of the carpus or the dactyl of the chelipeds. Ophthalmic scales long, narrow, pointed, margins entire.

Antennal acicle nearly straight, with two spines on the inner margin, one median, the other subproximal; as a variation there may be three spines. The acicle does not reach the cornea of the eye. The 3rd peduncle of the antennae reaches past the eye by nearly 1/3 its length, while that of the antennule exceeds the eye by ½ its length.

The chelipeds are subequal, similar, with tufts of setae; merus trigonal, with an upper crest of setae, the upper distal end and the subdistal margin are each armed with a single tooth, the inner lower margin spinulose, the outer granulose; the carpus in a lateral cross-section forms a quadrant, with the upper face rounding from the inner margin to the lower outer margin, the inner margin is armed with 6 spines, the anterior the largest, the outer margin is armed with 4 or 5 much smaller teeth, the surface between these ridges is smooth, the outer lower distal end, or hinge joint of the hand is spinulose; the hand is twice as long as wide and slightly more than a third its length in thickness, a lateral cross-section forming a quadrant, the inner margin of the palm is armed with 5 upward- and inward-pointing teeth, the outer margin of the hand is armed with small pointed tubercles, more numerous and larger on the pollex, the upper surface of the hand has 3 longitudinal rows of small, bristle-bearing tubercles, the crest of the dactyl is spinulose as is its upper surface, the fingers gape from base to corneous apices, and are armed with small calcareous denticules, the bases of the spines and spinules are setaceous.

The ambulatory legs are slender, the length of the dactyli slightly exceeding their propodi, the 1st pair are crested with spines on the carpus and propodus, the 2nd pair with a spinule on the upper distal end of the carpus only, both legs are margined with setae.

The distal margin of the telson is smooth, unarmed.

Color: In alcohol, the ground color is an iridescent cream with dashes and splotches of crimson, this extends to the chelipeds and legs, the former are more highly colored on the inside, while the latter appear to be banded. The setae are a straw colored yellow.

Measurements: Male holotype; length from rostrum to telson 27 mm., of anterior portion of carapace 3.5 mm., width 3.4 mm., length of cheliped 12 mm., of merus 3.8 mm., of carpus 3 mm., of hand 5 mm., of dactyl 3 mm., width of hand 2.3 mm., thickness 1.8 mm., length of eye-stalk 3.1 mm.

Range: So far only known from the Gulf of California.

Material Examined: A series of 85 specimens of both sexes from Arena Bank off Punta Arena, Lower California, Mexico (Station 136); the types were selected from this series which were collected in April and May of 1936, in from 30 to 85 fathoms. A series of 16 specimens of both sexes was

taken from Santa Inez Bay, Lower California, Mexico (Station 142, Dredge 3); April 11, 1936; in 40 fathoms. A male specimen from Gorda Bank, off Gorda Point, Lower California, Mexico (Station 150, Dredge 3); in 58 fathoms; April 21, 1936.

Remarks: This proposed species is allied to *P. sayi* A. M. Edwards and Bouvier, 1893, in that the antennal peduncles in both species exceed the eye; they differ in that the eye-stalks in *P. sayi* are short and heavy, while in this proposed species they are long and slender. This species also somewhat resembles the Indo-Pacific species *P. incomitatus* Alcock, 1905, in the shape of the chelipeds and the number of spines on the margin of the hand, and that the fingers do not close; it differs in that the antennae are long, instead of short.

Paguristes holmesi, sp. nov.

Type: Male, holotype; Cat. No. 36,1120, Department of Tropical Research of the New York Zoological Society; Station 150, Dredge 2; from the Gulf of California, 23° 01′ N. Lat., 109° 28′ W. Long., off Gorda Point, Lower California, Mexico; 75 fathoms; bottom sandy; April 21, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca.*

Diagnosis: Rostral tooth equal in length to laterals, just reaching bases of eye-scales. Chelipeds setaceous, spinose; hands more than 2/3 longer than wide; carpus with 5 marginal spines; hand with 4.

Description: Anterior portion of carapace longer than wide; front tridentate, rostral tooth triangular, not sharp, reaching to base of eye-scales; laterals obtuse, armed with a sharp marginal spine; rostral tooth subequal in length to laterals.

Eye-stalks long, slender, straight, not quite twice as long as the distance between the lateral spines of the carapace. Ophthalmic scales toothed on inner and outer margins, about 8 teeth in all. Third peduncle of antennule extends past cornea of eye about 1/5 its length.

Antennal acicle reaches 5/6 the length of the eye-stalk, is nearly straight and armed on both margins with spines, 3 on the proximal inner end, and 3 on the distal outer margin.

The chelipeds are subequal, similar, hairy and spinulose; merus spined on upper distal margin, behind which the subdistal margin is also spined, behind this latter margin are 2 or 3 smaller, lateral rows of spines, the inner and outer borders of the lower face are spinulose and tuberculate; carpus with 5 stout spines on upper inner edge, its upper surface, as is the hand, covered with upstanding, corneous-tipped spines, from the anterior bases of which are tufts of long yellow setae; the hands are widest at the base of the dactyli, about 2/3 as wide as long; inner edge of palm armed with 4 stout spines, with 3 much smaller ones below on inner face, and intermediate between them; the length of the dactyl equals the length of the palm, is spinulose like the upper surface of the palm and pollex, and is armed on its distal prehensile edge with a corneous, close set row of teeth, the median and proximal teeth are calcareous, as are those of the pollex, except for the corneous tip.

The ambulatory legs extend past the chelipeds by the length of their dactyli; the dactyli of the right side being slightly longer than those of the left; the carpus and propodus of the 1st pair of legs are crested with a row of stout spines; minute spines may or may not occur on the carpus of the 2nd legs, both pairs of legs and their dactyli are lined with tufts of yellow setae similar to that of the chelipeds.

Color: In alcohol, a light pinkish tint. Hands pinkish, flecked with red. Ambulatory legs iridescent on smooth surfaces; dactyli flecked with red. Eye-stalks white on upper surface, carmine on sides and beneath.

Measurements: Holotype, male; length from rostrum to telson 49 mm., of carapace 17 mm., of anterior portion of carapace 9.5 mm., width 8 mm., length of cheliped 25 mm., of hand 10.8 mm., width of hand 6.2 mm., length of dactyl 6.2 mm., of eye-stalk 6.8 mm., distance between laterals 3.8 mm., length of antennal flagellum 14.5 mm. An imperfect male paratype which is larger than the holotype has the following measurements: length from rostrum to telson 59 mm., of anterior portion of carapace 10.7 mm., width 9.8 mm., length of eye-stalk measured from base to tip of cornea 7.8 mm. In this specimen the rostral projection falls behind the laterals.

Range: Lower portion of the Gulf of California.

Material Examined: A series of 39 specimens, 27 males and 12 females, from Gorda Bank (Station 150), off Gorda Point, Lower California, Mexico; in from 50 to 85 fathoms; April 22 to May 3, 1936; the types were selected from this series. One male from Arena Bank (Station 136), Gulf of California, off Cape Pulmo, Lower California, and one male from Station 126, Dredge 1; from east of Cedros Island, west side of Lower California, in 28° 07′ N. Lat., 115° 09′ W. Long.; in 38 fathoms; March 27, 1936.

Remarks: This proposed species is allied to *P. ulreyi* Schmitt, 1921, but differs in that the antennae are not thickly haired, instead of being thickly haired underneath; by having 4 spines on the inner margin of the palm and 3 smaller ones below these, instead of having 3 spines on the margin with 2 beneath; by the ophthalmic scales being spinulose on both margins, instead of with 4 or 5 spines at the tip. This proposed species also closely resembles *P. bakeri* Holmes, 1900, in the size, shape, coloration and general disposition of the spines on the chelipeds, but differs in the contour of the hands, those of *P. bakeri* being much the wider of the two species.

This species is named for Dr. Samuel J. Holmes, of the University of California, in appreciation of his work in crustacea, and for the favors he has granted me.

Paguristes oculiviolaceus, sp. nov.

Type: Male, holotype; Cat. No. 36,796, Department of Tropical Research of the New York Zoological Society; Station 150, Dredge 3; from Gorda Bank, Gulf of California, 23° 00′ N. Lat., 109° 28′ W. Long., off Gorda Point, Lower California, Mexico; 58 fathoms; bottom sandy; April 21, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Median tooth extending past laterals, reaching well between the eye-scales, equilateral. Eye-stalks long, straight, slightly ciliated at cornea, violet colored. Chelipeds with heaviest spines on inner margins, 5 on carpus, 4 on manus. Antennal flagellum lightly ciliated.

Description: Anterior portion of carapace longer than wide, seminude; median tooth equilateral, extending past the laterals and well between the eye-scales; laterals obtuse, armed with a marginal spinule. The posterior margin of the carapace with a median concavity.

Eye-stalks long, straight, slightly dilated at the cornea, subequal in length to that of the dactyl of the chelipeds, and extends to the subdistal margin of the merus. Ophthalmic scales wide at base, with bifid tips; inner margin entire.

Antennal acicle nearly straight, armed on inner margin with 4 sharp teeth, outer margin with 1, tip bifid, it extends but little past half the length of the eye. The 3rd peduncle of the antennae reaches 2/3 the length of the eye, while that of the antennule reaches half its length past the eye. The antennal flagellum is sparsely ciliated and reaches the proximal end of the hand.

The chelipeds are subequal, similar, with tufts of setae; merus trigonal,

subequal in length to the width of the carapace, with a thin crest of setae, distal and subdistal margins armed with a few spines, lower inner margin with a few spines, the outer with setae and spinules; the carpus is armed on its inner margin with a row of 5 upward- and forward-pointing, corneous-tipped spines, a row of smaller similar spines parallel the marginal spines, the outer margin is outlined with still smaller spines, below which, on the outer surface, is a row of still lesser spinules, the anterior bases of the spines are tufted with short setae; the hand is spinulose on its upper surface, and rounded down to its outer margin, it is subequal in length to the length of the anterior portion of the carapace, the inner margin of the palm is armed with 4 teeth, similar to those on the carpus, the proximal two having a common base, the distal two are entire and separate, the outer margin, like the surface of the hand and fingers, is roughened with small setaceous spinules, the pollex is wider than the dactyl, corneous-tipped, the fingers gape evenly from base to corneous, spoon-shaped apices.

The ambulatory legs are slender, crested with short setae, and exceed the length of the chelipeds by half their dactyli; the dactyli being nearly as long as their carpus and propodus combined; the carpus and propodus of the first pair are crested with spines, those of the second pair are lightly rugose.

The distal margin of the telson is margined with corneous-tipped spines.

Color: In alcohol, the carapace and legs are buff with pinkish iridescence, the inner side of the merus of the chelipeds is a dull orange. The remarkable feature is the brilliant violet color of the eye peduncles and the antennules. The setae are a straw color.

Measurements: Male holotype; length from rostrum to telson 31 mm., of anterior portion of carapace 5.3 mm., width 4.5 mm., length of cheliped 13 mm., of merus 4.5 mm., of carpus 2.9 mm., of hand 5.5 mm., of dactyl 3.5 mm., width of hand 3 mm., thickness 2 mm., length of eye-stalk 3.5 mm.

Material Examined: The male holotype and the male paratype from the type locality.

Remarks: This proposed species is allied to *P. lymani* Milne Edwards and Bouvier, 1893, which it somewhat resembles in the number and disposition, but not in the shape, of the spines on the chelipeds. It differs also in the following respects: rostrum exceeding laterals, instead of not being so far advanced; eye-scales slender to the bifid tip, instead of stout; terminal margin of telson with a few well separated teeth, instead of with many close-set teeth. The shape of the chelipeds also somewhat resembles those of *P. puniceus* Henderson, 1896, an Indo-Pacific species.

Paguristes aztatlanensis, sp. nov.

Type: Female, holotype; Cat. No. 36,788, Department of Tropical Research of the New York Zoological Society; Station 136, Dredge 27; from the Gulf of California, 23° 28′ N. Lat., 109° 24′ W. Long., 3 miles northeast of Cape Pulmo, Lower California, Mexico; 50 fathoms; sandy bottom with rock; April 30, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Rostral tooth long, sharp, triangular, slightly exceeding laterals, extending between bases of eye-scales. Eye-stalks extending past merus. Flagellum short, lightly ciliated. Chelipeds densely spinulose, pubescent; carpus with 4 inner-marginal spines; palm of hand with 3; tips of fingers spooned.

Description: Anterior portion of carapace nearly 1/3 longer than wide, the width subequal to the length of the hands, with a few setae, rugose, and a few spinules on lateral regions. Median tooth forms an acute triangular rostrum, slightly exceeding the laterals, which are obtuse and armed with a

small marginal spine; between the median spine and the laterals the margin is concave and thickened. The gastric lobes are well defined anteriorly.

Eye-stalks straight, cylindrical, subequal in length to that of the merus, and extending past that member by nearly half their length. The ophthalmic scales are subquadrate at their base, with short equilateral apices, armed at the tip with one or more apical spines. The distal end of the antennular peduncle just exceeds the tip of the eye.

The antennal acicle is slender, short, extending but half the length of the eye-stalk, bifid at the tip, armed with 3 well-formed spines on inner margin, with 2 on the outer distal margin, and is lightly setose; the segment behind the base of the acicle has one or more well developed spines, its distal outer terminus is bifid, the outer margin spinulose. The distal end of the 3rd peduncle is but little advanced beyond the acicle. The flagellum is short, lightly ciliated and subequal in length to that of the merus.

The chelipeds are short, subsimilar, equal, the carpus and manus covered with short, black-tipped spines, the largest on the inner margins, these spines are nearly covered with pubescence, growing less thick at the base of the fingers; the merus is trigonal, smooth on the inner side, rugose on the outer, armed on the distal and subdistal margin with a few spines, the lower inner margin with spine-tipped tubercules; the carpus has 4 inner-marginal spines and a row of 5 smaller spines on the outer margin, and a prominent spine over the upper articulation with the hand; the hands are rounded over from the inner margin, which is armed with 3 spines, the surface having many short, sharp-tipped spines visible through the pubescence, the length of the dactyl is subequal to the width of the hand, its thickness is 2/3 its width, the fingers meet on the upper surface and are excavated beneath, with corneous semi-spoon-shaped tips.

The ambulatory legs are stout, setose and pubescent on their margins, and extend past the chelipeds by the length of their dactyli, the carpus, propodus and dactyls have numerous rows of small corneous-tipped spines. The rasps of the 3rd and 4th legs and also those of the uropods are composed of short, dark, corneous spinules. The terminal margin of the telson is armed with wide-spaced teeth.

Variation: Of the two female specimens taken, one, the holotype, had occupied a shell with a circular aperture, while its companion, a non-ovigerous female, had occupied a shell with a wide narrow slit, similar to that of a *Conus*. This opening vertically constricted the animal's carapace and distorted its appearance, as is the carapace of *P. digueti* Bouvier, 1892, which occupies the shell of a *Strombus*.

Color: In alcohol, a pinkish tint on an ivory ground.

Measurements: Female holotype; length from rostrum to telson 34 mm., of anterior portion of carapace 9 mm., width 5.3 mm., length of cheliped 16 mm., of merus 4.5 mm., of carpus 4 mm., of hand 5.5 mm., width of hand 3 mm., thickness 2 mm., length of eye-stalk 4.3 mm., length of flagellum of antennae 4.6 mm.

Range: Known only from type locality.

Material Examined: Two female specimens from the same dredge haul, the holotype the larger of the two.

Remarks: This proposed species is closely allied to *P. fecundus* Faxon, 1893, but differs in that the terminal lobes of the telson are distinctly toothed on their margins, instead of obscurely toothed, by the antennal acicle reaching 2/3 the distance of the eye peduncle, instead of nearly to the end of the peduncle, by the ischium of the outer maxillipeds being armed on their inner margins with a serrate row of short teeth, the merus is unarmed, instead of armed with 3 or 4 denticles on the lower margin of the merus.

Aztatlan is a name for the prehistoric Mexican frontier on the Pacific coast.

Genus *Petrochirus* Stimpson.

Petrochirus californiensis Bouvier.

Petrochirus californiensis Bouvier. *Bull. Mus. d'Hist. Nat. Paris,* no. 1, 1895, p. 6 (type-locality, not given; Lower California); Nobili, *Boll. Mus. Zool. Anat. comp. R. Univ. Torino,* vol. 16, no. 415, 1901, p. 24.

General Range: Gulf of California to Ecuador. (Nobili).

Local Distribution: A single male specimen from Monument Beach, Santa Inez Bay, Baja California, Mexico; collected April 12, 1936.

Sex and Size: A male specimen with the following measurements: (the first figures given are for the specimen collected by this expedition; the second figures are for those of a normally large male collected by the author at Punta Penasco, Sonora, Mexico; May 3, 1935) length from rostrum to telson 98 mm.-128 mm., of carapace 29 mm.-38 mm., of precervical portion of carapace 12.6 mm.-17 mm., width of same 13.5 mm.-18 mm., length of major cheliped 62 mm.-74 mm., of merus 14 mm.-20 mm., of carpus 15 mm.-20 mm., of manus 28 mm.-38 mm., of dactyl 15 mm.-21 mm., width of manus 12 mm.-18 mm., thickness of manus 11 mm.-17.5 mm., length of eye-stalks 12.6 mm.-17 mm.

Color in Alcohol: A bluish-red. Chelipeds and ambulatories with blood-red maculations on inner and outer distal ends of meri; fingers of chelipeds white. Eye-stalks a taupe, with a deep red, inverted, V-shaped marking at distal upper end. Antennal flagellum banded red and white. Setae on dactyli of walking legs a red brown.

Habits, Habitat: This large pagurid is somewhat sluggish in its movements. Most of the specimens collected in the inter-tidal zone, in the Gulf of California, were occupying the shell of *Phyllonotus nigritus* (Philippi), and were accompanied by a polynoid worm and commensal porcellanids.

Remarks: This is the first record of the finding of this common and conspicuous crab in the waters where it was first discovered by Diguet, since Bouvier wrote its all too brief description.

Genus *Dardanus* Paulson.

Dardanus sinistripes (Stimpson).

Pagurus sinistripes Stimpson. *Ann. Lyc. Nat. Hist.,* N. Y., vol. 7, 1859, p. 82 (type-locality, Panama); Bouvier, *Bull. Mus. d'Hist. Nat. Paris,* no. 1, 1895, p. 8; Nobili, *Boll. Mus. Zool. Anat. comp. R. Univ. Torino,* vol. 16, no. 415, 1901, p. 23 (Ecuador).

Dardanus sinistripes (Stimpson). Rathbun, *Proc. U. S. Nat. Mus.,* vol. 38, 1910, p. 556, pl. 49, fig. 2, and p. 597; Schmitt, *Proc. Calif. Acad. Sci.,* vol. 13, no. 24, p. 382.

General Range: From the Gulf of California to Peru (Rathbun).

Local Distribution: A total of 27 specimens was taken off Arena Bank (Station 136); 14 adults and several juveniles were taken in Santa Inez Bay (Stations 141, 142 and 143 respectively); 2 specimens were taken off Gorda Bank (Station 150 D-3). All of the above specimens were dredged in depths ranging from 10 to 60 fathoms. In addition to these specimens, a larval form was taken (Cat. No. 36,784) from off Arena Bank (Station 136).

Sex and Size: The entire series taken at the above stations is composed of 20 males, 23 females and 2 juveniles, and ranges in size from the first adult form to the largest yet to be recorded. The largest specimen, a male, has the following dimensions: length from rostrum to telson 110 mm., of

Genus *Petrochirus* Stimpson.

Petrochirus californiensis Bouvier.

Petrochirus californiensis Bouvier. *Bull. Mus. d'Hist. Nat. Paris*, no. 1, 1895, p. 6 (type-locality, not given; Lower California); Nobili, *Boll. Mus. Zool. Anat. comp. R. Univ. Torino*, vol. 16, no. 415, 1901, p. 24.

General Range: Gulf of California to Ecuador. (Nobili).

Local Distribution: A single male specimen from Monument Beach, Santa Inez Bay, Baja California, Mexico; collected April 12, 1936.

Sex and Size: A male specimen with the following measurements: (the first figures given are for the specimen collected by this expedition; the second figures are for those of a normally large male collected by the author at Punta Penasco, Sonora, Mexico; May 3, 1935) length from rostrum to telson 98 mm.-128 mm., of carapace 29 mm.-38 mm., of precervical portion of carapace 12.6 mm.-17 mm., width of same 13.5 mm.-18 mm., length of major cheliped 62 mm.-74 mm., of merus 14 mm.-20 mm., of carpus 15 mm.-20 mm., of manus 28 mm.-38 mm., of dactyl 15 mm.-21 mm., width of manus 12 mm.-18 mm., thickness of manus 11 mm.-17.5 mm., length of eye-stalks 12.6 mm.-

carapace 28 mm., of precervical portion 15 mm., width of same 14 mm., length of major cheliped 62 mm., of merus 14 mm., of carpus 13 mm., of manus 27 mm., width of manus 18 mm., length of eye-stalk 10 mm.

Color: In alcohol, the carapace is buff with red markings. The chelipeds, purple and red, with the interior margins of the meri white; the teeth of the fingers white, bordered with yellow. The ambulatory legs are purple, their dactyli with dark brown setae, their meri and carpi blotched on a light ground with red.

Habits, Habitat: The majority of the species of the genus *Dardanus* are inhabitants of the Indo-Pacific region, but 3 species are recorded from the Pacific coasts of North and South America. *D. sinistripes* is not an intertidal form, so far as the records show, but occupies the zone between 10 and 60 fathoms. It occupies any sort of shell from those having a large round opening to those with a narrow aperture, such as *Conus*.

Remarks: In the collection here assembled is a specimen of *Glaucothöe* H. M. Edwards, 1830, (Cat. No. 36,784) from off Arena Bank (Station 136).

Bouvier has ably pointed out that the genus *Glaucothöe*, is simply the larval stage of a pagurid, being without sex, and as such I regard it, and believe it is entitled to neither individual generic nor specific standing.

This specimen of larval form, or "*Glaucothöe*," I refer without hesitation to the genus *Dardanus*, and believe it to be the last larval stage of *Dardanus sinistripes* (Stimpson). In arriving at this conclusion, I have compared the larva with a series of juvenile specimens from this and other collections of *D. sinistripes*, among which were several specimens that exhibited the first adult form, in which the chelipeds are still quite similar, the abdomen still well segmented, though not calcareous or chitonous, the telson still much longer in proportion than that of the mature form. In comparing the larva with these juveniles, the following similarities of form become apparent: the eyes are similar in shape and size; the hands are similar in size, the fingers opening in the same plane; the 4th and 5th legs are similar, namely, subchelate and chelate; in both the abdomen is clearly segmented, though in the juvenile it is slightly coiled and not straight as in the larva; the telsons of both are long and subsimilar in shape.

Genus *Calcinus* Dana.

Calcinus californiensis Bouvier.

Calcinus californiensis Bouvier. *Bull. Mus. d'Hist. Nat. Paris*, no. 8, 1898, p. 380 (type-locality, San Jose Island, Gulf of California).

General Range: Gulf of California. Acapulco, Mexico.

Local Distribution: A total of 13 specimens (Cat. No. 36,815) was taken off Arena Bank (Station 136) in coral (*Pocillopora ligulata*) at a depth of 2½ fathoms.

Sex and Size: The series consists of 6 males and 7 females. The largest specimen, a male, has the following dimensions: length from rostrum to telson 25 mm., of carapace 8 mm., of precervical portion of carapace 4.2 mm., width of same 3.6 mm., length of major cheliped 14.5 mm., of merus 3.3 mm., of carpus 3 mm., of manus 6 mm., of dactyl 3.5 mm., width of manus 4 mm., length of eye-stalk 3.8 mm.

Color in Alcohol: Reddish with white spots showing through on carapace. Chelipeds a dark brown with small bluish spots; carpus and manus margined with red. Ambulatory legs and dactyli red. Tips of fingers white.

Habits, Habitat: This inter-tidal species occupies the lower half of the tidal zone, where it is very plentiful throughout its range. An active, gregarious little animal, utilizing any of the smaller shells for an abode.

Remarks: This is the first record of *C. californiensis* having been taken since Diguet's two specimens were described by Bouvier. Bouvier remarked that this species is closely allied to *C. obscurus* Stimpson, 1859, and like myself, had none of the latter species with which to compare his specimens. As a means of quick identification, I would say that this species, *C. californiensis*, may be distinguished from *C. obscurus* by the solid color of the ambulatory dactyli, as in the latter species the dactyli are banded.

Genus *Pylopagurus* M. Edw. and Bouvier.

Pylopagurus varians (Benedict), new combination.

Eupagurus varians Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 24 (type-locality, Gulf of California); Bouvier, *Bull. Mus. Hist. Nat. Paris*, no. 8, 1898, p. 382.

General Range: So far only recorded from the Gulf of California.

Local Distribution: Two specimens, one from Arena Bank (Station 136 D-24), the other from Santa Inez Bay (Station 143 D-5), with a depth range of from 18 to 50 fathoms.

Sex and Size: Both specimens were males; the largest, from Santa Inez Bay, has the following measurements: length from rostrum to telson 34 mm., of carapace 8.3 mm. (carapace with a deep V-shaped notch in posterior margin), of precervical portion of carapace 5 mm., width of same 4.8 mm., length of major cheliped 38.4 mm., of merus 6.2 mm., of carpus 9 mm., of manus 13 mm., of dactyl 8.2 mm., width of manus 6.6 mm., length of eye-stalk 4 mm.

Color in Alcohol: Carapace a cream with a few red spots near cervical groove. Chelipeds a pinkish-buff, with deep red spots. Ambulatory legs banded with white and a yellow-red.

Habits, Habitat: This hermit crab is one of the few that does not have to change its abode as it grows larger, for the original shell which it occupies becomes incrusted with a bryozoan growth, which the crab is able to control at the aperture by using its large hand as an operculum; thus the aperture of the shell is always smooth, while the rest of the shell takes on varied and weird shapes. Not an inter-tidal form.

Remarks: It seems remarkable that Bouvier, who was the co-author of the genus *Pylopagurus*, retained Benedict's genus *Eupagurus* for this species, when he recorded Diguet's collection in 1898. The lack of a figure for this species is confusing.

Pylopagurus cervicornis (Benedict), new combination.

Eupagurus cervicornis Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 25 (type-locality, Gulf of California).

General Range: The Gulf of California.

Local Distribution: A total of 21 adult specimens and 2 juveniles was taken on Arena Bank (Station 136) in different dredges, in from 30 to 50 fathoms.

Sex and Size: This series consists of 19 males, 2 of them juvenile, and 4 females, none of them very large. The largest male in this series has the following dimensions: length from rostrum to telson 22 mm., of carapace 6 mm. (carapace with a deep V-shaped notch in posterior margin), of precervical portion of carapace 3.6 mm., width of same 3.2 mm., length of major cheliped 23.2 mm., of merus 3.6 mm., of carpus 5 mm., of manus 7.6 mm., of dactyl 5 mm., width of hand 5 mm., length of eye-stalk 3 mm.

Color in Alcohol: Carapace a cream with a few spots of red near the cervical groove on the calcified portion. Chelipeds a pinkish-buff, with deep red spots. Ambulatory legs banded with white and a yellow-red.

Habits, Habitat: This species occupies the same sort of abode as that of *P. varians*. One small specimen (Cat. No. 36,361) occupied a hole in a small sponge.

Remarks: These two species, *P. varians* and *P. cervicornis*, may prove to be one and the same species, one a variety of the other, when it is possible to get a large series of adult forms, from both ends of the Gulf of California, together for comparison. There seems to be an intergradation which is difficult otherwise to explain.

Pylopagurus coronatus (Benedict), new combination.

Eupagurus coronatus Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 24 (type-locality, Gulf of California).

General Range: Gulf of California.

Local Distribution: A single specimen was taken on Arena Bank (Station 136 D-24), in 50 fathoms.

Sex and Size: A male specimen with the following dimensions: length from rostrum to telson 15 mm., of carapace 4.5 mm., of precervical portion of carapace 3 mm., width of same 2.8 mm., length of major cheliped 11.4 mm., of merus 2.4 mm., of carpus 3 mm., of manus 5 mm., of dactyl 3.5 mm., width of manus 3.5 mm., length of eye-stalk 2.7 mm.

Color in Alcohol: Carapace, chelipeds and ambulatory legs have a whitish ground color, on which, in various patterns, is laid an orange-yellow and red. The pattern is sharp cut, distinctive, irregular, unblended.

Habitat: Little is known of the habits of this pagurid, as all specimens so far examined have been removed from their shell. It is not a shore form, but may be expected in depths of from 25 to 100 fathoms, within its range.

Remarks: This record, like several others, is the first, since the species was described nearly 45 years ago. From its scarcity in this and other dredgings examined, it appears to be a rare form.

Pylopagurus guatemoci, sp. nov.

Type: Male, holotype; Cat. No. 36,801, Department of Tropical Research of the New York Zoological Society; Station 175, Dredge 1; from location 5 miles west of San Jose Point, Pacific side of Baja California, 31° 25′ N. Lat., 116° 42′ W. Long., 45 fathoms; bottom shaley; May 24, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Calcified portion of carapace as broad as long, transversely convex, naked, polished, projections subequal. Major hand margined with large teeth, becoming smaller distally; minor hand heavily toothed on outer margin. Eyes long, slightly constricted in middle, cornea dilated.

Description: Anterior portion of carapace as broad as long, transversely convex, naked, polished; median projection obtuse, depressed, not extending past base of eye-scales, nor past the spinule-tipped, obtuse, lateral projections.

The eye-stalks are cylindrical, slightly constricted in the middle, and subequal in length to the merus of the major chela. The ophthalmic scales have broad bases and triangular apices, with margins entire; the subterminal spine is long, sharp, stout, and is situated just inside the point of

the scale. The distal end of the second peduncle of the antennule reaches the cornea.

The antennal acicle is slight, sharp-pointed, unarmed, except for a few hairs, and extends to the cornea of the eye. The third antennal peduncle extends half its length past the eye. The flagellum extends to the base of the major dactyl and is ciliated with occasional long and short hairs.

The chelipeds, as in the genus, are dissimilar and unequal. In the major cheliped the merus is trigonal, crested with a few short hairs; the distal lower tip of the ischium extends nearly to the distal lower margin of the merus; the carpus is widened distally, is subequal in length to the width of the carapace, is armed on its inner margin with two large, well formed teeth, one over the hinge of the hand, the other median, these are separated by a wide sinus, the median tooth is supported posteriorly by a ridge, there is no outer margin as the surface arches from the inner border to the lower outer margin, a few setae in tufts of three or four are on this surface, on the under surface the carpus is very narrow, almost a bridge, and deeply excavated on its forward surface for the reception of the hand; the hand, on its operculiform portion, is 4/5 as wide as long, the toothed proximal border is nearly straight, the rim of teeth is uneven in size, some teeth are double, others single with their tips bent inward, these tips are corneous spinules, the distal teeth of the dactyl and pollex are much smaller and more uniform than those of the palm; the excavated surface of the hand is microscopically set with minute corneous spine-tipped granules; the fingers are crossed at their corneous tips, joined on their upper surfaces and excavated beneath, armed on their cutting edges with calcareous lobes, the under side of the hand has a few scattered setae; the minor hand extends to the base of the major dactyl; the carpus is bicristate, with the spines of the outer margin more prominent; the hand is flattened on its upper surface, twice as long as wide, with a median row of spines to the gape, the outer margin with a raised crest of spines nearly to the corneous tip of the pollex, these spines are similar, though smaller, to those on the major hand, the inner margin is unarmed, lightly setose, as is the under side of the hand.

The ambulatory legs are unarmed on their upper crests, lightly setose, with a high polished surface, shorter than the major chela.

The terminal segment of the abdomen is a single, undivided, semioval plate, the distal margin unarmed, entire, and projecting equally on both sides.

Color: In alcohol, an ivory mottled with red. The spines of the chelipeds have a faint purple tint. The ambulatories are banded with red and a bluish-white, the latter color is distal on the joints.

Measurements: Length from rostrum to telson 19 mm., of carapace 5 mm., of anterior portion of carapace 3 mm., width 3 mm., length of major chela 12.5 mm., of merus 2.3 mm., of carpus 3 mm., of flat portion of manus 5 mm., width 3.8 mm., length of minor manus 3 mm., width 1.5 mm., length of eye-stalk 2.4 mm.

Range: Known only from type-locality.

Remarks: This proposed species is allied to *P. coronatus* (Benedict), 1892, but differs in that the merus of the major cheliped is lightly rugose, instead of with a thin subserrate crest; by the carpus being uncrested on the median line, instead of with a subserrate crest; by the spines bordering the hand being tipped with minute, corneous spinules, instead of being untipped with spinules; by the minor hand having its outer margin serrate with teeth, instead of having a subserrate ridge. In both species the ultimate segment of the telson is similar.

This species is named for Guatemotzin, or Guatemoc, the last Aztec sovereign in Mexico.

Pylopagurus spinicarpus Glassell, manuscript name.

Material: A total of 2 specimens was taken from Santa Inez Bay (Station 147), and Gorda Bank (Station 150), between 60 and 80 fathoms

The specimens were distributed as follows:

Station 147: D-2 (1 male); 60 fathoms.
Station 150: D-13 (1 male); 70 to 80 fathoms.

Genus *Pagurus* Fabricus.

Key to species of Pagurus *collected on this expedition.*

A. Eye-stalks short, stout; cornea dilated.
- B. Hand margined with spines, granulose. Antennal acicle extending past cornea. Rostrum not advanced past laterals.
  - C. Hand about twice as long as wide. *P. smithi*, p. 259
  - C'. Hand about as long as wide. *P. merimaculosus*, p. 259
- B'. Hand not margined with spines, granulose.
  - C. Hand 3 times as long as wide. Antennal acicle extending past cornea. Rostrum advanced past laterals. *P. gladius*, p. 257
  - C'. Hand about twice as long as wide. Antennal acicle not extending past cornea. Rostrum not advanced past laterals, or, but slightly advanced. *P. albus*, p. 258

A'. Eye-stalks cylindrical, stout; cornea slightly dilated. Antennal acicle not extending past cornea.
- B. Hand margined with spines, spinulose, setaceous; about twice as long as wide. Rostrum advanced past laterals. Pollex deeply concave. *P. pollexcavus*, p. 261
- B'. Hand not margined with spines, granulose; about as long as wide. Rostrum not advanced past laterals. Pollex not concave. *P. californiensis*, p. 257

A". Eye-stalks expanded at their base; cornea not dilated. Antennal acicle not extending past cornea. Hand margined with spines, spinulose, setaceous; about twice as long as wide. Rostrum advanced past laterals. *P. lepidus*, p. 256

Pagurus lepidus (Bouvier), new combination.

Eupagurus lepidus Bouvier. *Bull. Mus. d'Hist. Nat. Paris*, no. 8, 1898, p. 381 (type-locality, La Paz Bay, Baja California).

General Range: Gulf of California.

Local Distribution: A total of 5 specimens was taken near shore at Santa Inez Bay (Station 144 D-1), at a depth of 1 fathom.

Sex and Size: This series contains 3 males and 2 ovigerous females. The largest specimen, a male, has the following dimensions: length from rostrum to telson 13.5 mm., of carapace 3.8 mm., of precervical portion of carapace 2.4 mm., width of same 2.2 mm., length of merus of major cheliped 1.8 mm., of carpus 1.6 mm., of manus 3 mm., width of same 1.5 mm., length of eye-stalk 1.6 mm.

Color: In alcohol, the carapace is a buff. The merus of the chelipeds is red-brown and buff, the hands and carpus yellow, the finger tips white. Ambulatory legs cream, with all joints striated with red-brown. Flagellum of antennae with 3 or more segments red-brown separated from the next series by a white segment.

Habitat: This little hermit crab frequents the lower tidal levels, seeking shelter among marine growths.

Remarks: This is the first record of this species having been taken in the Gulf of California in 40 years. It may be mentioned, however, that it is not a rare form, but obscure.

Pagurus californiensis (Benedict).

Eupagurus californiensis Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 21 (type-locality, California); Faxon, *Mem. Mus. Comp. Zool. Harvard*, vol. 18, 1895, p. 55, pl. 11, figs. 2-2f; Bouvier, *Bull. Mus. d'Hist. Nat. Paris*, 1898, p. 382.

Pagurus californiensis (Benedict). Holmes, *Occas. Papers Calif. Acad. Sci.*, vol. 7, 1900, p. 149; Rathbun, *Harriman Alaska Expedition*, vol. 10, 1910, p. 161; Schmitt, *Univ. Cal. Pub. Zool.*, vol. 23, 1921, p. 143, text-fig. 93; Boone, *Zoologica*, N. Y. Zool. Soc., vol. 14, no. 1, 1932, p. 9, text-fig. 3.

General Range: From California to Panama. Galápagos Islands (Boone).

Local Distribution: A total of 14 specimens was taken from Arena Bank (Station 136) and Santa Inez Bay (Stations 142 and 143 respectively), at depths ranging from 25 to 50 fathoms.

Sex and Size: The collection numbers 6 males and 8 females. The largest male (Cat. No. 36,790) from Santa Inez Bay (Station 143 D-4) has the following measurements: length from rostrum to telson 40 mm., of carapace 10 mm., of precervical portion of carapace 6.1 mm., width of same 5.6 mm., length of major cheliped 29 mm., of merus 7.2 mm., of carpus 7 mm., of manus 12.5 mm., of dactyl 6.3 mm., width of manus 9.8 mm., length of eye-stalk 5 mm.

Habits, Habitat: In the Gulf of California, this species is only found in depths ranging from 15 to 50 fathoms, while along the California coast, in cooler waters, it is often taken at low tide. Faxon records his specimens at a depth of 66 fathoms, at Panama. Boone records her specimens as having been taken at a depth of 2½ fathoms, in the cooler waters of the Galápagos Islands.

Remarks: This species registers considerable variation in the smoothness of the upper surface of the hand, some specimens being quite tuberculate on the distal half, others smooth. The size and shape of the inner margin of the hand also shows considerable variation in different individuals, some being much larger than others, although the individuals may be of the same size.

Pagurus gladius (Benedict).

Eupagurus gladius Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 7 (type-locality, Gulf of California); Nobili, *Boll. Mus. Zool. Anat. comp. R. Univ. Torino*, vol. 16, no. 415, 1901, p. 22.

Pagurus gladius (Benedict). Rathbun, *Proc. U. S. Nat. Mus.*, vol. 38, 1910, p. 597.

General Range: From the Gulf of California to Ecuador (Nobili).

Local Distribution: A total of 11 specimens was taken from Arena Bank (Station 136 D-14), and Santa Inez Bay (Station 143 D-2 and D-5), at depths ranging from 18 to 45 fathoms.

Sex and Size: The collection numbers 6 males and 5 females, the greater number of these being half grown. As the two largest specimens in this

series had lost their major chelipeds, it was thought best to give the measurements of a normal adult male, in the author's collection, taken off Carmen Island, in Salinas Bay, Gulf of California; December 19, 1931; in 30 fathoms. The above specimen has the following dimensions: length from rostrum to telson 28 mm., of carapace 10 mm., of precervical portion of carapace 4.8 mm., width of same 6 mm., length of major cheliped 41.5 mm., of merus 11 mm., of carpus 11 mm., of manus 16.5 mm., of dactyl 6.5 mm., width of manus 4.5 mm., length of eye-stalk 4 mm.

Color: In alcohol, the carapace is a dark cream maculated with red and purple. Chelipeds and ambulatories with a purple tinge and red spots; a dark purple stain on hand near dactyl; propodus and dactyli of ambulatories banded with purple. Eye-stalks mottled.

Habits, Habitat: This active pagurid apparently occupies the zone between the depths of 20 and 50 fathoms; at any rate it has not so far been reported from the tidal zone. It prefers a small, fragile shell, which only partly covers its carapace. This shell, like those favored by *P. splendescens* Owen, 1839, becomes partly disintegrated from the action of the polyps or bryozoans which cover the anterior portion of the shell.

Remarks: As it is not known at what part of the Gulf of California the type specimen was found, it is impossible to state an extension of range, even though it be a distance of several hundred miles, until specimens are collected outside of this area. It is possible also, that Nobili had a different species to work on, for he finds differences between his specimen and Benedict's description, which an examination of a series, such as this, from the Gulf of California, does not bear out.

Pagurus albus (Benedict).

Eupagurus albus Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 6 (type-locality, Gulf of California).

Not *Pagurus albus* (Benedict). Boone, *Bull. Vanderbilt Marine Mus.*, vol. 3, 1930, pp. 34-36, pl. 5.

General Range: So far known only from the Gulf of California.

Local Distribution: A single specimen from Santa Inez Bay (Station 144 D-7), taken at a depth of 3 fathoms.

Sex and Size: A single, partly damaged, juvenile female. As this specimen may not be suitable for measurement, I will supply the dimensions of a normal male, collected by myself on Turner Island, Gulf of California; December 31, 1931; in the inter-tidal zone. The measurements are: length from rostrum to telson 26 mm., of carapace 9.5 mm., of precervical portion of carapace 5.5 mm., width of same 5.7 mm., length of major cheliped 23 mm., of merus 5.8 mm., of carpus 6.3 mm., of manus 8 mm., of dactyl 4.2 mm., width of manus 3 mm., length of eye-stalk 3.8 mm.

Color in Life: The conspicuous feature of this crab is the whiteness of the hands.

Habits, Habitat: This pagurid is a tidal form which may be taken at shallow depths. It is extremely active, a fast traveler, and is found racing along the bottom in a few inches of water at extreme low tide. At no collecting station, in spite of their conspicuous color, have they been observed to be very numerous.

Remarks: This species appears to be closely allied to *P. gladius* (Benedict), but while *P. gladius* occupies the lower zone in the same region, *P. albus* occupies the upper.

Pagurus smithi (Benedict), new combination.

Eupagurus smithi Benedict. *Proc. U. S. Nat. Mus.*, vol. 15, 1892, p. 4 (type-locality, Gulf of California).

Not *Eupagurus smithii* Milne Edwards and Bouvier. *Mem. Mus. Comp. Zool.*, vol. 14, no. 3, 1893, p. 140, pl. 10, figs. 1-12 (type-locality, Sand Key, Florida), (= *Pagurus bouvieri* (Faxon), 1895).

General Range: So far only known from the Gulf of California.

Local Distribution: A total of 9 specimens was taken at Santa Inez Bay (Station 143 D-1, D-2, D-3 and D-5), at depths ranging from 18 to 35 fathoms.

Sex and Size: This series consists of 2 males and 7 females. The largest male (Cat. No. 36,291) has the following dimensions: length from rostrum to telson 58 mm., of carapace 17 mm., of precervical portion of carapace 7.6 mm., width of same 8.5 mm., length of major cheliped 33 mm., of merus 10 mm., of carpus 8.5 mm., of manus 13.1 mm., of dactyl 7.5 mm., width of manus 7.5 mm., length of eye-stalk 7 mm.

Color in Alcohol: Carapace and eye-stalks buff. Chelipeds with carpus and manus a light orange; inner margins of pollices and dactyli white. Ambulatory legs buff.

Habitat: Evidently not a shore form, as they were only found at depths ranging to 35 fathoms.

Remarks: Bottom conditions may have something to do with the apparently localized finding of this form, as they were taken at only one Station (143). The original description gives the type-locality as Gulf of California, so that we have little information on the original finding, as to depth or distribution. This is the first record of the taking of this pagurid in 45 years.

Pagurus merimaculosus, sp. nov.

Type: Male, holotype; Cat. No. 361,126, Department of Tropical Research of the New York Zoological Society; Station 136, Dredge 14; from the Gulf of California, 23° 29′ 30″ N. Lat., 109° 25′ W. Long., 3 miles northeast of Cape Pulmo, Lower California, Mexico; 45 fathoms; bottom muddy; April 20, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Precervical portion of carapace about as long as wide, almost naked. Front obtuse, not extending past laterals. Eye-stalks stout, short; cornea dilated. Antennal acicle extending past eye. Carpus of major hand concave on inner side, margined with 9 or more conical spines; hand 3/5 as wide as long, heavily plated with short spined granulations. Inner and outer distal ends of meri of chelipeds and 1st and 2nd ambulatories with a distinctive blood-red spot.

Description: Calcified portion of carapace about as long as wide, almost naked, except for a few short setae. Rostral projection obtuse, not extending past the laterals, nor much more than reaching the bases of the eye-scales; lateral projections equilateral, armed with a minute subapical spine.

Eye-stalks stout, nearly 2/3 the length of the anterior portion of the carapace, cornea expanded. Ophthalmic scales distant, semioval at base, subacute, concave distally, margins entire; a small subterminal spine.

The antennal acicles are long, narrow, sharp-pointed, and extend past the eyes to a point near the base of the flagellum.

The major cheliped is large, strong, wide, well margined; merus extending well past the eyes, inner side straight, outer side rounding, the distal

posterior margins of both sides have a row of small teeth; the upper flattened carpal margin is armed with a row of horizontal, long, sharp spines; the carpus increases in width distally, where it is more than 2/3 as wide as long; the inner margin is armed with a row of forward- and upward-pointing spines, the outer margin is well defined, granulous, and with a row of setae; the upper surface is slightly convex, rugose and granulate, more prominent distally; the surface of the outer side of the carpus is vertical, that of the inner concave; the hand is rectangular, 3/5 as wide as long; the inner and outer margins are armed with a row of regularly spaced, outward- and upward-pointing, conical teeth; the proximal margin armed with 2 conical, vertical teeth, one near the inner hinge, the other median; the upper surface is slightly convex and densely pebbled or plated with irregular, sharp-tipped granules, continued onto the pollex and dactyl, these granules have distinct margins and do not coalesce; the dactyl is crested with spines, as is the hand, and is armed on its prehensile edge with calcareous blunt teeth, as is the pollex. The minor cheliped is slightly shorter than the major, the corneous tips of the fingers reaching to a point about midway on the major dactyl; the merus is compressed, rounded on top, and like the major merus is distally armed with spines on the upper carpal and outer distal margins, but is unarmed on the inner side; the lower surface of both meri is tuberculate; the carpus is of irregular shape, narrower proximally than distally, and wider ventrally than dorsally at the distal end; the outer upper margin has a crest of sharp-pointed, conical spines, those of the inner margin are much smaller; the surface between the crests is concave and lightly roughened; the hand is subcylindrical, oval in transverse cross-section and bends downward at the tip; the surface is similar to that of the major hand; the inner edge of the pollex is covered with a multitude of small conical teeth; the inner edge of the dactyl is unarmed except for a short pile of baleen-like material.

The 1st and 2nd ambulatory legs are slightly longer than the chelipeds, sparsely crested with short setae, almost smooth, shining; the distal upper end of the carpus of the 1st legs is armed with two spinules, those of the 2nd legs with one; the dactyli are compressed, slightly contorted, smooth and shining on the posterior side and lightly setaceous anteriorly; including their corneous tip, they are nearly equal in length to the two preceding joints combined.

Color: In alcohol, the eye-stalks and ambulatory legs appear to be banded with a light pink and ivory. The most distinctive markings are the blood-red spots on each side of the distal, inner and outer ends of the meri of the chelipeds and ambulatory legs; these spots persist undimmed for a long time in preservative.

Measurements: Male holotype: length from rostral projection to telson 45 mm., of calcified portion of carapace 7 mm., width 7.3 mm., length of eye-stalk and cornea 5.3 mm., width of cornea 2.4 mm., length of acicle 5.1 mm., of major cheliped 34 mm., length of merus 8 mm., carpus 9 mm., distal width 7 mm., proximal width 4.5 mm., length of hand 15 mm., width 9 mm., length of minor hand 11 mm., width 4.5 mm., length of dactyl 7.5 mm.

Range: So far known only from the lower end of the Gulf of California.

Material Examined: A series of 28 specimens, 12 males and 16 females, some ovigerous, from Arena Bank (Station 136), off Cape Pulmo, Lower California, Mexico; in from 35 to 45 fathoms; April 3 to 30, 1936. Also, a series of 16 specimens, 8 males and 8 females, from Santa Inez Bay (Station 143), Lower California, Mexico; in 40 fathoms; April 11, 1936. Both series collected by William Beebe. The types were selected from the first series.

Remarks: This proposed species is allied to *P. smithi* (Benedict), 1892, the major chelipeds being somewhat similar in conformation; the granules of the hands and the shape of the dorsal surface of the carpus in the two

species are much alike; however, they differ in the minor hands. In *P. smithi*, the minor hand is similar to that of the major hand, being flattened, instead of being unrelated and subcylindrical. In *P. merimaculosus*, the upper crest of the carpi of the ambulatory legs has only one or two spinules at their upper distal end, while in *P. smithi*, the entire crest of the carpal joints is spinulose. In addition, *P. smithi* would appear to be a smaller form.

Pagurus pollexcavus, sp. nov.

Type: Male, holotype; Cat. No. 361,127, Department of Tropical Research of the New York Zoological Society; Station 150, Dredge 13; from the Gulf of California, 23° 02′ N. Lat., 109° 27′ 30″ W. Long., off Gorda Point, Lower California, Mexico; 75-80 fathoms; bottom sandy; April 23, 1936; 4-foot Blake dredge; collected by William Beebe on Templeton Crocker's yacht *Zaca*.

Diagnosis: Precervical portion of carapace as long as wide; median tooth wide, triangular, slightly exceeding laterals. Eye-stalks stout, cylindrical; cornea slightly dilated. Antennal acicle not extending past cornea. Hands nearly twice as long as wide, margined with spines; upper surface on proximal half heavily spined and setose; pollex and dactyl concave, naked, smooth, paved with gear-edged, coalesced granules. Ambulatory legs unarmed except for upper distal carpal spinules. Distal margin of telson toothed.

Description: Calcified portion of carapace about as long as wide, naked, except for a few tufts of short setae. Posterior margin of carapace deeply indented. Rostral tooth broadly triangular, exceeding laterals and extending between bases of eye-scales; lateral projections obtuse, with a minute subapical spinule.

Eye-stalks stout, cylindrical, subequal in length to major dactyl; cornea slightly dilated. Ophthalmic scales distant, broad at base, apex triangular, surface slightly concave between margins; a strong subterminal spine. Distal end of 2nd antennular peduncle just reaches the cornea.

The antennal acicles are slightly arcuate, unarmed, with few setae, and extend well into the cornea. The 3rd peduncle of the antennae exceeds the cornea by 1/3 its length. The flagellum exceeds the length of the major cheliped and has a few short cilia.

The major cheliped is 2/3 the length of the body; the merus is armed on its distal upper edge with a single forward-pointing spine; the upper and outer surface is lightly rugose; the inner and outer lower margins are spinulose; the under surface tuberculate; the carpus is widest distally, where it is subequal in width to the hand, its inner margin armed with a row of 6 or more forward-pointing, conical spines, inside of which are several smaller spines; the outer margin is not defined with spines; the upper surface is lightly setose, with small, scattered, sharp-tipped granules; the manus is nearly twice as long as wide, heavily spined and setose on its proximal half; the pollex is deeply concave from its upward-pointing, spined outer margin to a median longitudinal row of spines from base to tip; the concave surfaces of the pollices and dactyli of both hands are paved with smooth, closely meshed, coalesced, gear-edged granulations; the fingers are armed with calcareous lobes, and gape slightly from base to apex. The minor cheliped reaches to the base of the dactyl of the major hand; the merus is compressed and deep, it is armed on its distal, outer ventral margin with a prominent row of spines; the carpus is narrow and deep, the thickness being nearly 2/3 the length, proximally the upper surface is bicrestate, unicrested distally on the outer margin; distally the lower outer margin is spined; the manus is somewhat similar to that of the major hand, except that the concave pavement extends, on the outer half, to a point near the proximal end; the

remainder of the upper surface of the hand is setose, with a median row of spines which margin the paved area.

The ambulatory legs are subequal in length to the major cheliped, lightly setose; the carpi armed at their distal upper ends with a single spinule; the dactyli are compressed and slightly longer than their propodi. The terminal lobes of the telson are armed on their inner margins with 4 or more well spaced, incurving spines.

Color: In alcohol, the ground color is an ivory, overlaid with pink and spotted with small blood-red spots. The under side of the eye-stalks is red, the upper part a cream. The propodi of the ambulatories have a median band of pink. The setae are a straw yellow.

Measurements: Male holotype: length from rostrum to telson 41 mm., of carapace 10 mm., of anterior portion of carapace 5.5 mm., width 5.5 mm., length of major cheliped 30 mm., of merus 5.8 mm., of carpus 6.5 mm., of manus 10 mm., of dactyl 5 mm., width of manus 6 mm., length of eye-stalk 4.5 mm., distance between laterals 3 mm.

Material Examined: A series of 10 males and 12 females, 1 ovigerous, from Gorda Bank (Station 150), off Gorda Point, Lower California, Mexico; in from 67 to 80 fathoms; April 21 to May 3, 1936. The types were selected from this series. Three specimens, 1 male and 2 females, 1 ovigerous, from Arena Bank (Station 136), 3 miles NE of Cape Pulmo, Lower California, Mexico; in from 42 to 50 fathoms; May 1-2, 1936. All collected by this expedition.

Range: So far only known from the lower end of the Gulf of California.

Remarks: This proposed species is distantly allied to *P. tanneri* (Benedict), 1892, which it somewhat resembles in the shape of the carapace and general contour of the chelipeds; it differs in that the median tooth of the carapace is not so far advanced, the eyes not so stout and dilated, the antennal acicle not so long; the merus and carpus of the chelipeds are somewhat similar, but the hands differ by being spined and setose on the proximal half, instead of tumid and spined in a regular pattern; the pollex is deeply concave and smoothly paved, instead of slightly concave and spinulose; by the ambulatory legs being unarmed, instead of armed on the crests of the carpus and propodus.

Pagurus bunomanus Glassell, manuscript name.

Material: A total of 8 specimens was taken from Arena Bank (Station 136), and Clarion Island (Station 163 D-2), in the Revilla Gigedo Group, 3 miles off Pyramid Rock, in depths ranging to 50 fathoms.

The specimens were distributed as follows:

Station 136: (3 males, 1 female).
Station 163: D-2 (1 male, 3 females, 1 ovigerous); 50 fathoms.

Genus *Catapagurus* Milne Edwards.

Catapagurus diomedeae Faxon.

Catapagurus diomedeae Faxon. *Bull. Mus. Comp. Zool. Harvard,* vol. 24, no. 7, 1893, p. 171 (type-locality, off Cocos Island); and, *Mem. Mus. Comp. Zool. Harvard,* vol. 18, 1895, p. 57, pl. 13, figs. 2-2d.

General Range: From the Gulf of California to the Bay of Panama.

Local Distribution: A total of 4 specimens was taken on Arena Bank (Station 136) and in Santa Inez Bay (Stations 146 D-1 and 147 D-2 respectively), at depths ranging from 35 to 60 fathoms.

Sex and Size: The entire series is composed of 2 males and 2 females, one a juvenile. The largest female specimen from Arena Bank, has the following measurements: length from rostrum to telson 23 mm., of carapace 7.6 mm., of precervical portion of carapace 4.5 mm., width of same 4 mm., length of cheliped 18 mm., of merus 4.8 mm., of carpus 4.8 mm., of manus 6.5 mm., of dactyl 2.7 mm., width of manus 2.1 mm., length of eye-stalk 3.4 mm.

Color in Alcohol: Carapace, chelipeds and eye-stalks, a cream with light red markings. Chelipeds and ambulatory legs with yellow setae, pollex with a purple banding. Walking legs with pink or purple banding.

Remarks: This record is not only an extension of range for this species, but it is also the first record of the species having been taken since Faxon described and figured it. Faxon's specimen was taken at a depth of 182 fathoms, while the above series was collected at a depth not to exceed 60 fathoms.

Genus *Spiropagurus* Stimpson.

Spiropagurus occidentalis Faxon.

Spiropagurus occidentalis Faxon. *Bull. Mus. Comp. Zool. Harvard,* vol. 24, no. 7, 1893, p. 172 (type-locality, off Cocos Island); and, *Mem. Mus. Comp. Zool. Harvard,* vol. 18, 1895, p. 59, pl. 14, figs. 1-1d.

General Range: From the Gulf of California to the Bay of Panama.

Local Distribution: A total of 4 specimens was taken on Arena Bank (Station 136), and in Santa Inez Bay (Station 147 D-2), at depths ranging from 35 to 60 fathoms.

Sex and Size: This series consists of 2 males and 2 females, one ovigerous, all of small size. The largest male from Station 136 has the following dimensions: length from rostrum to telson 16.5 mm., of carapace 5.5 mm., of precervical portion of carapace 3.5 mm., width of same 3.2 mm., length of cheliped 12.7 mm., of merus 3.2 mm., of carpus 3 mm., of manus 5.5 mm., of dactyl 2.2 mm., width of manus 2.1 mm., length of eye-stalk 2.2 mm.

Color in Alcohol: Nearly all trace of color has disappeared in solution from the carapace and chelipeds, except for small purple markings along the margins of the hands and purple bands near the fingers; also there is purple on the spines of the carpus. The ambulatory legs appear to have been banded purple and white.

Remarks: This record extends the range for this species from Cocos Island, off Panama, to the Gulf of California. It is also the first record of the species having been taken since its discovery. The bathymetric ranges are very similar.

17.

Caudal Skeleton of Bermuda Shallow Water Fishes. II. Order Percomorphi, Suborder Percesoces: Atherinidae, Mugilidae, Sphyraenidae[1].

GLORIA HOLLISTER
Department of Tropical Research.

(Text-figures 1 to 14).

OUTLINE.

INTRODUCTION.

This is the second of a series of papers dealing with the caudal skeleton of Bermuda fishes.[2] This paper deals principally with the adult fishes, as does Part I on the Bermuda Isospondyli, but when young stages were available these were included.

In Atherinidae, *Menidia notata* is known from Bermuda by a single record, (Barbour, *Bull. Mus. Comp. Zool.*, vol. XLVI, No. 7, page 116, 1905). The single specimen upon which it is based could not be found. This record is questionable and it is possible that *Menidia* does not exist in Bermuda. The account of *Menidia menidia* has already been shown to be *Atherina harringtonensis*. (Beebe and Tee-Van, *Zoologica*, XIII, 7, 1933, page 143). *Menidia* has not been taken by us and as *Atherina* is common, *Menidia notata* is not included in this study, on the assumption that the single record is the same as *Atherina harringtonensis*.

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[1] Contribution No. 532, Department of Tropical Research, New York Zoological Society.
Contribution from the Bermuda Biological Station for Research, Inc.

[2] Caudal Skeleton of Bermuda Shallow Water Fishes. I. Order Isospondyli: Elopidae, Megalopidae, Albulidae, Clupeidae, Dussumieriidae, Engraulidae. *Zoologica*, New York Zoological Society, Vol. XXI, Dec. 31, 1936.

KEY TO CAUDAL FIN OF BERMUDA SHALLOW WATER PERCESOCID FISHES.

(Text-figs. 1-3).

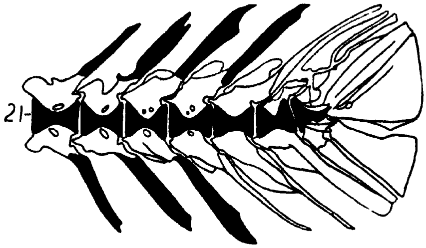
PERCOMORPHI

Percesoces

Group I

Broad posterior neural and haemal spines;
21 caudal vertebrae;
43 total vertebrae;
2 epurals, rarely 1.

ATHERINIDAE
Atherina harringtonensis



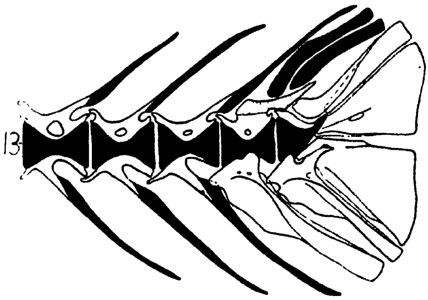
Text-figure 1.

Sub-Group A

2 epurals;
epural bases anterior to neural of last centrum;
neural of last centrum sharply pointed;
13 caudal vertebrae;
Post. haemal processes arise on anterior half of centra.

MUGILIDAE
Mugil curema
Mugil trichodon
Mugil brasiliensis

Text-figure 2.



Group II

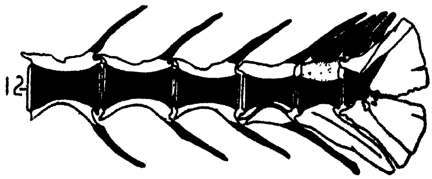
Slender posterior neural and haemal spines;
12 or 13 caudal vertebrae;
24 total vertebrae;
2 or 3 epurals.

Sub-Group B

3 epurals;
epural bases not anterior to neural of last centrum;
neural of last centrum not pointed;
12 caudal vertebrae.
Post. haemal processes arise on post. half of centra.

SPHYRAENIDAE
Sphyraena barracuda
Sphyraena borealis

Text-figure 3.



In Mugilidae, *Mugil curema* is the common species. *Mugil trichodon* and *Mugil brasiliensis* are the uncommon species. The latter has not been taken during our seven seasons of work in Bermuda. Three specimens were presented for this study by the United States National Museum.

In Sphyraenidae, *Sphyraena sphyraena* is omitted, being a questionable species in Bermuda. In the "Field Book of the Shore Fishes of Bermuda," Beebe and Tee-Van, it "has twice been recorded from Bermuda. Both records are questionable and it is possible that the fish does not occur here at all." Because of almost identical characters of the osteology of the tail, *S. borealis* and *S. picudilla* are in this paper considered as one, and the name *Sphyraena borealis,* is used for both.

The length of specimens in this paper is standard length unless otherwise stated.

For caudal fin terminology, complete bibliography, and method of preparing specimens for this study, refer to Part I.

The symbols used in the figures are UN, uroneurals; EP, epurals; 1, 2, 3 etc., hypurals.

We are indebted to the American Museum of Natural History for specimens of *Menidia notata* and to the U. S. National Museum for three specimens of *Mugil brasiliensis.* I take this opportunity to thank Dr. William Beebe, Director of this Department, for his continued encouragement, and Mr. John Tee-Van for his cooperation. The drawings are by Mr. George Swanson and the author.

In the key a single figure is used to represent the three species of Mugilidae and another for the two species of Sphyraenidae. In both families the drawings are of the largest adults of the common species, *Mugil curema* and *Sphyraena barracuda.* The slight differences found in the caudal pattern of the other species are described in the text.

ATHERINIDAE.

Atherina harringtonensis Goode.

(Text-figs. 4-7).

Diagnostic Characters:

4 hypurals, 2 dorsal and 2 ventral in 64 mm. fishes.
5 hypurals, 3 dorsal and 2 ventral in 28 mm. and smaller fishes.
Several broad posterior neural and haemal spines.
2 epurals in all specimens but one of 64 mm.
Vertebral count: 21 caudal plus 22 trunk. Total 43.

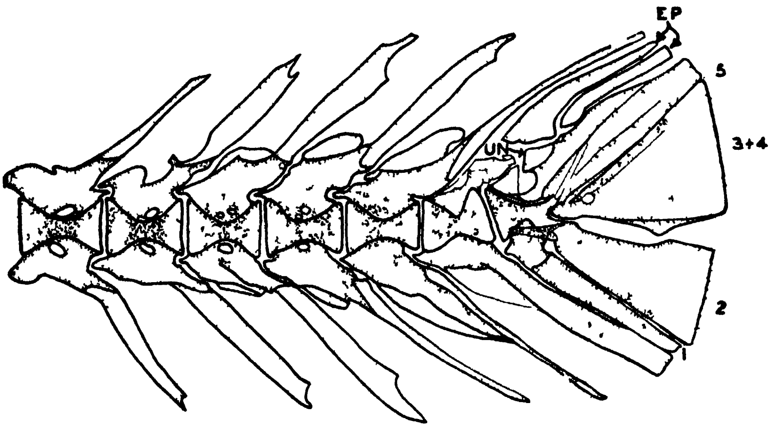
Material Studied.

Length.	*KOH Cat. No.*	*Text-fig. No.*	*Ossification.*
64 mm.	654	4	Complete.
60 mm.	855		"
55 mm.	654		"
52 mm.	654		"
50 mm.	205		"
50 mm.	656		"
47 mm.	206		"
47 mm.	1072		"
45 mm.	654		"
38 mm.	654		"
37 mm.	205		"
35 mm.	206		"
35 mm.	654 (2 spec.).		"

Length.	*KOH Cat. No.*	*Text-fig. No.*	*Ossification.*
28 mm.	654 (2 spec.).	5	Complete.
13 mm.	2106 (2 spec.).	6	Partial.
9 mm.	2106		Slight, vertebral column segmented.
6 mm.	2106 (2 spec.).	7	None, vert. column unsegmented.
5 mm.	2106	7	None.

Caudal Osteology.

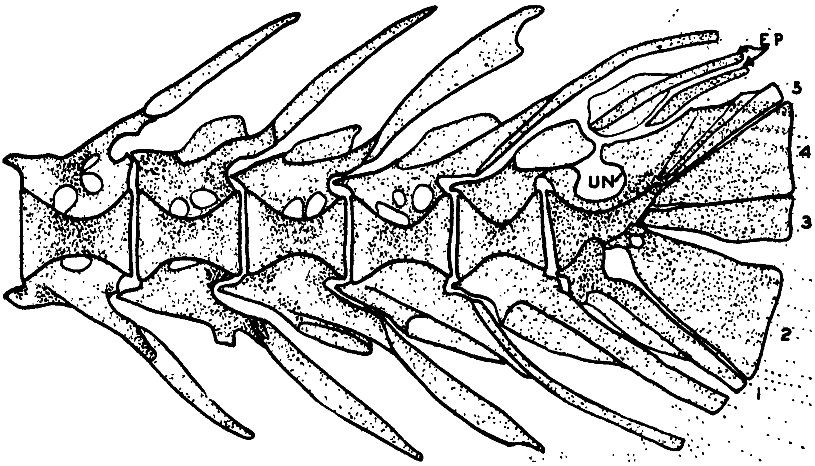
Urostyle: Separate segments of the urostyle cannot be found in any of the specimens examined which range in size from 5 mm. to 64 mm. In the 64 mm. fishes the urostyle is very much reduced, its blunt posterior end appearing above the base of the dorsal fan-like hypural. In the 28 mm. specimen it is near the base of the 4th hypural. In the 13 mm. fish, which is not completely ossified, it is even more elongated and the tip is rounder and lies above the base of the 5th hypural. In the 5 mm. fish, which has no evidence of ossification, the vertebral segments are not developed and the urostyle extends dorsally beyond the distal margin of the 5th or dorsalmost hypural.



Text-figure 4.

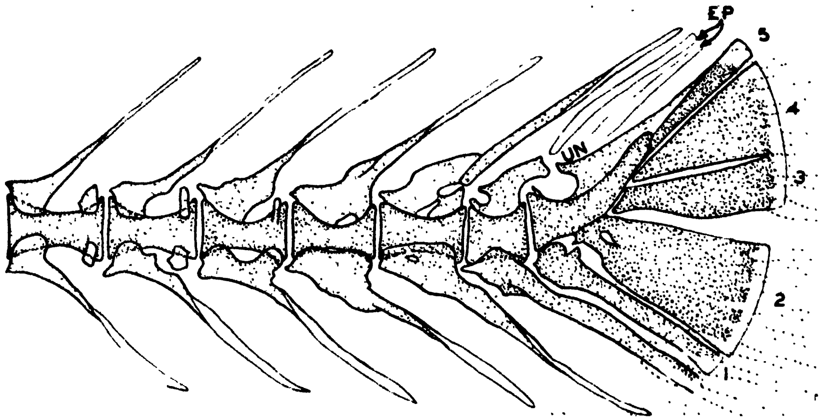
Atherina harringtonensis. Tail of 64 mm. specimen with 3d and 4th hypurals fused, and 5th hypural consolidated with the uroneural. (x 11.9).

Uroneurals: In the 13 mm. specimen one pair of uroneurals is present which covers all but the anterior margin of the dorsal surface of the urostyle which is covered by the diminutive zygapophysis. In the two larger stages the uroneurals are enlarged and have become one with the base of the zygapophysis, and the depth has increased so that the area between the urostyle and the epurals is almost completely filled. In the 13 mm. fish the distal end of the uroneurals is closely connected with the dorsal surface of the dorsalmost hypural. In the larger specimens the line of junction between the two is faint and the identity of the two bones is further complicated by additional lines. But from the structure of the 13 mm. specimen it is thought that the adult has but one pair of uroneurals.



Text-figure 5.

Atherina harringtonensis. Tail of 28 mm. specimen with the five hypurals defined but the dorsal surface of the 5th united with the uroneural. (x 29.8).

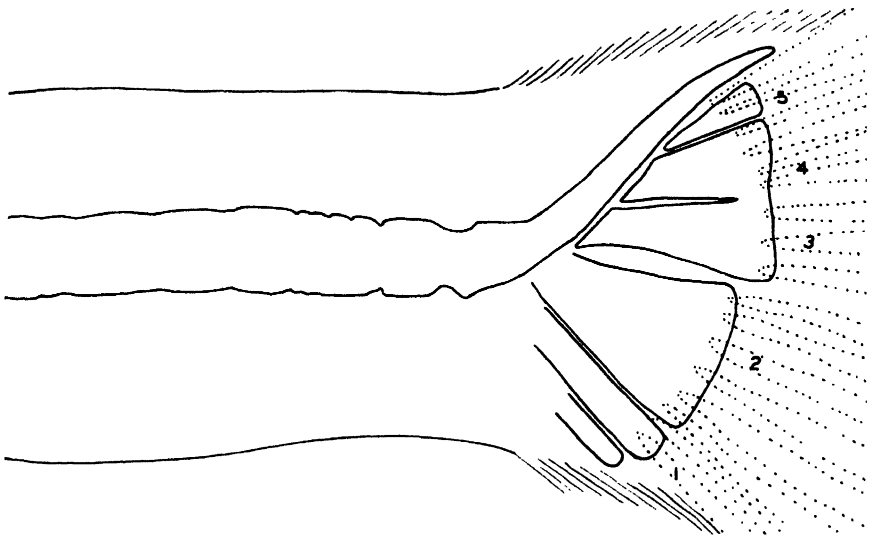


Text-figure 6.

Atherina harringtonensis. Tail of 13 mm. specimen with the unossified areas not stippled. (x 45.6).

Hypurals: There are four hypurals, two below and two above the median line, in the largest or 64 mm. specimens. In the 28 mm. and smaller fishes there are five hypurals, two below and three above the median line. In

all specimens there remains evidence of a one-time division of the second hypural which is indicated by a small hole near the base. In the 28 mm. fish the heavy spine of the 1st hypural has been omitted in the illustration in order to show the base of the 2nd hypural with the hole and the double nature of the arch portion. (Text-fig. 5). In all of the Bermuda Isospondyli there are three hypurals below the median line, instead of two found in the Bermuda Percesoces.



Text-figure 7.

Atherina harringtonensis. Tail of 5 mm. specimen which is unossified. The column is unsegmented into vertebrae. (x 93.2).

In the 64 mm. *Atherina* the 3rd and 4th hypurals have united to form a large fan-shaped bone similar to the one below the median line. The complete outline of the 5th hypural is difficult to trace in specimens over 28 mm. in length when it becomes united dorsally with the uroneurals. In the younger stages it is clearly defined both in position and outline.

Epurals: There are two epurals in all specimens examined except one 64 mm. long. In the 13 mm. fish the epurals are not ossified and their outline can only faintly and incompletely be traced. In all larger specimens the epurals are long flat bones and the anterior one is always longer and broader, having a larger area to fill.

Specialized Neural Processes: The spine of the neural process on the terminal posterior centrum is greatly reduced, with a blunt distal portion which, in the large specimens, overlaps the zygapophysis of the urostyle and extends almost to the base of the anterior epural. The neural arches, as well as the haemal arches, have complicated superstructures which do not appear in the two other families of this suborder.

Caudal Fin Ray Count:

64 mm.	$\frac{9 + 10 = 19}{9 + 9 = 18}$	(Text-fig. 4).
28 mm.	$\frac{9 + 8 = 17}{9 + 8 = 17}$	(Text-fig. 5).
13 mm.	$\frac{10 + 9 = 19}{9 + 8 = 17}$	(Text-fig. 6).
9 mm.	$\frac{17}{16}$	
5 mm.	$\frac{9}{8}$	(Text-fig. 7).

MUGILIDAE.

1. *Mugil curema* Cuvier and Valenciennes.

Diagnostic Characters:

4 hypurals, 2 dorsal and 2 ventral in 10 mm. and larger fishes.

6 hypurals indicated in the unossified 6 mm. specimen.

Narrow posterior neural and haemal spines.

2 epurals whose bases are anterior to the tip of the neural of the last centrum.

Neural spine of the last centrum sharply pointed.

Haemal processes arising on the anterior half of the caudal centra.

Vertebral count: 13 caudal plus 11 trunk. Total 24.

Material Studied.

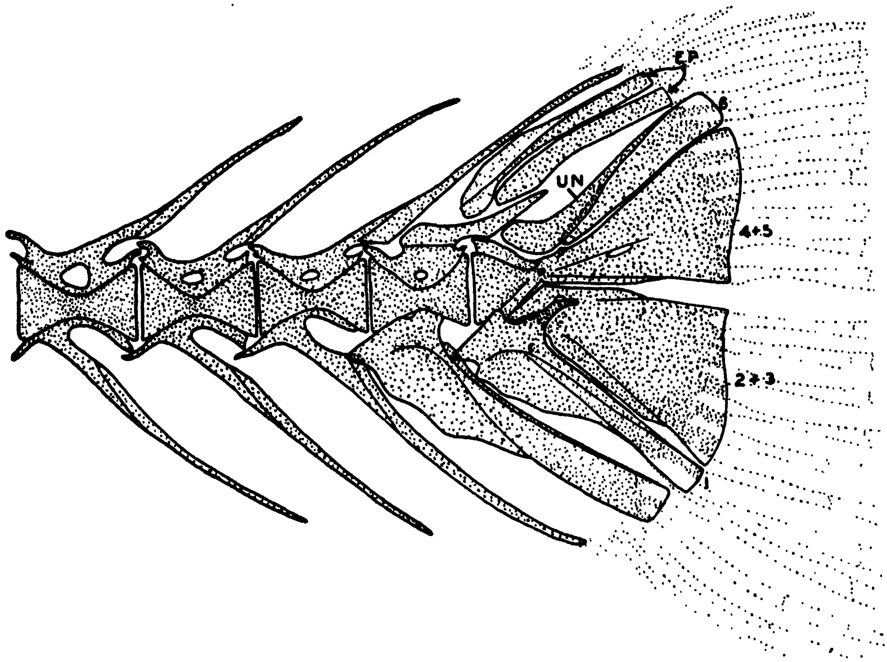
Specimens ranging in size from 4 mm. to 23 mm., taken in Haiti, were used for additional study but not tabulated below. One is included in this study which is a stage not found in our Bermuda material.

Length.	*Cat. No.*	*KOH Cat. No.*	*Text-fig. No.*	*Ossification.*
202 mm.	9474	979		Complete.
149 mm.	25041	1045		"
70 mm.	25042	1044	8	"
49 mm.		593		"
32 mm.		593		"
32 mm.		503		"
30 mm.		503		"
30 mm.		2094		"
28 mm.		2094		"
25 mm.		2094		"
12 mm.*	16465	594	9	Partial.
10 mm.	7306 (Haiti).	2093	10	Partial, column segmented.
6 mm.†	19757b	2107	11	Slight, column unsegmented.

*Dip net 5 miles off shore.
†Surface net 3 miles off Gurnets.

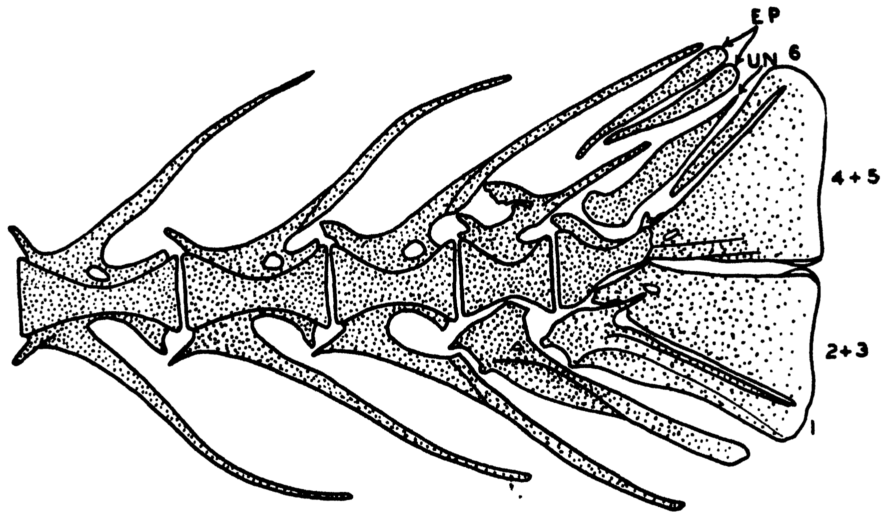
Caudal Osteology.

Urostyle: The urostyle segment looks like a perfect half centrum. No separate elements can be seen in the reduced urostyle of specimens which range in length from 202 mm. to 12 mm. In a 10 mm. fish the upturned urostyle is more prolonged than in the 12 mm. specimen and extends to the



Text-figure 8.

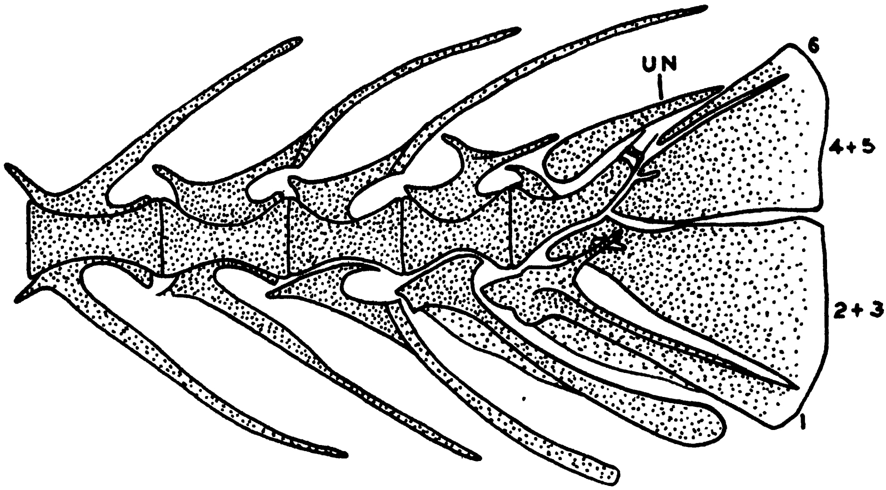
Mugil curema. Tail of 70 mm. specimen which represents all larger stages in our collection. (x 8.7).



Text-figure 9.

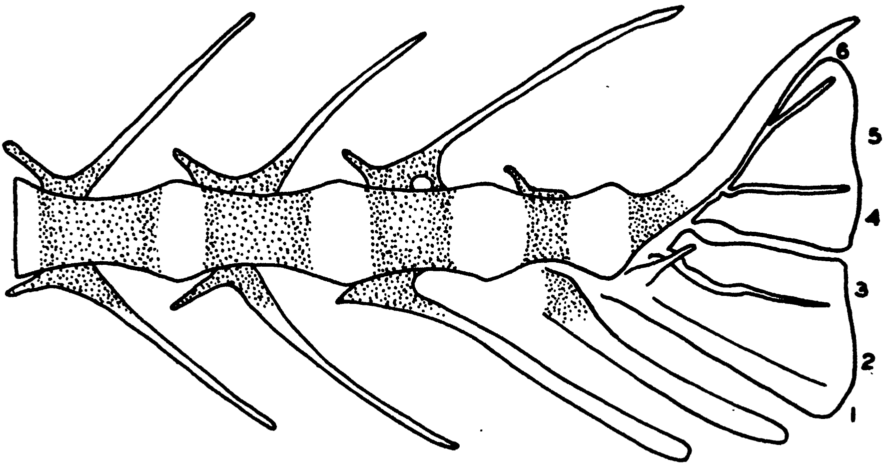
Mugil curema. Tail of 12 mm. specimen showing remnants of the urostyle, immature epurals and uroneurals and partially ossified skeleton. (x 43.2).

dorsal margin of the base of the upper fan-shaped hypural. Extending beyond is the remnant of the unossified notochord. The 6 mm. specimen, which has only slight ossification in the center of the developing centra and



Text-figure 10.

Mugil curema. Tail of 10 mm. specimen only partially ossified, hypural bases free from upturned urostyle, margins of centra in conjunction, no epurals and skeleton only partially ossified. (x 53.7).



Text-figure 11.

Mugil curema. Tail of 6 mm. specimen which is only slightly ossified and the vertebral column as yet unsegmented. The urostyle is prolonged beyond the margin of the hypurals. The bases of six hypurals are distinct. (x 73.2).

the neural and haemal arches, has a prolonged notochord which curves dorsally beyond the margin of the dorsalmost hypural.

Uroneurals: There is one pair of uroneurals, the two bones of which are club-shaped ventrally and taper dorsally to a slender tip. In the 70 mm. specimen they extend almost to the dorsal margin of the 4th hypural. In this and larger specimens the ventral half of the uroneurals overlaps the side of the 4th hypural. In smaller specimens there is definite space between the two bones. In 12 mm. and 10 mm. fishes the dorsal tip reaches half and

a little more than half the length of their respective hypurals. In the slightly ossified 6 mm. specimen there is no evidence of the uroneurals.

Hypurals: There are four hypurals, two below and two above the median line in all specimens of 10 mm. and larger. There is indication of six hypurals in the 6 mm. specimen, none of which is ossified. Here the bases are deeply cleft but these do not extend through the distal margin to divide the bone into two hypurals. With growth the clefts gradually disappear and only a small hole remains at the base. This condition is also seen in *Atherina*. As in *Atherina* and *Sphyraena* there are two large fan-shaped hypurals, one dorsal and one ventral to the median line.

Epurals: Two epurals are present in all specimens ranging from 12 mm. to the largest. Both are long, flat bones which are slightly larger at the ventral end. The epurals are first seen in the 12 mm. fish and here the ventral ends are more slender than the dorsal. But with growth the ventral ends become larger. The bases of both epurals are anterior to the posterior tip of the last neural spine.

Specialized Neural Processes: The spine of the neural process on the terminal posterior centrum is reduced but more spine-like than in Atherinidae and Sphyraenidae. It differs from the neural process of both families in being long and slender and its pointed distal tip extending posteriorly and dorsally beyond the ventral bases of both epurals. The illustrations show the progressive growth of this bone.

Caudal Fin Ray Count:

149 mm.	$\dfrac{5 + 10 = 15}{6 + 10 = 16}$	
70 mm.	$\dfrac{5 + 10 = 15}{6 + 10 = 16}$	(Text-fig. 8).
49 mm.	$\dfrac{4 + 10 = 14}{6 + 9 = 15}$	
32 mm.	$\dfrac{6 + 8 = 14}{7 + 8 = 15}$	
25 mm.	$\dfrac{7 + 8 = 15}{8 + 8 = 16}$	
6 mm.	$\dfrac{13}{13}$	

Additional Characters Worthy of Note: The bases of the posterior caudal haemal arches arise anterior to the center of their centra and, on the posterior half of the centra, form a deep-cut U. This pattern is distinctive and does not exist in Atherinidae or Sphyraenidae. In the latter the haemal arches arise posterior, instead of anterior, to the center of the centra.

2. *Mugil trichodon* Poey.

3. *Mugil brasiliensis* Agassiz.

The caudal patterns of *Mugil trichodon* and *Mugil brasiliensis* are almost identical and are not noticeably different from *Mugil curema*. The vertebral count is the same in the three species; 13 caudal plus 11 trunk. Total 24.

In *Mugil trichodon* the scales are larger and the body more slender and the skeleton more slender and the reverse is true in *Mugil brasiliensis*.

MUGIL TRICHODON.

Material Studied.

Length.	*KOH Cat. No.*	*Cat. No.*	*Caudal Fin Ray Count.*
165 mm.	2167		$\frac{4 + 10 = 14}{3 + 9 = 12}$
48 mm.	2168		$\frac{4 + 10 = 14}{4 + 10 = 14}$
46 mm.	2168		$\frac{6 + 9 = 15}{4 + 10 = 14}$

MUGIL BRASILIENSIS.

Material Studied.

190 mm.	2169	2128 U. S. Nat. Mus.	$\frac{3 + 10 = 13}{5 + 9 = 14}$
92 mm.	2170	66247 U. S. Nat. Mus.	
35 mm.	2171	86914 U. S. Nat. Mus.	$\frac{5 + 9 = 14}{4 + 9 = 13}$

SPHYRAENIDAE.

1. **Sphyraena barracuda** (Walbaum).

(Text-figs. 12-14).

Diagnostic Characters:

4 hypurals, 2 dorsal and 2 ventral in two largest fishes.
6 hypurals, 3 dorsal and 3 ventral in 115 mm. fish.
Narrow posterior neural and haemal spines.
3 epurals with bases of posterior two back of neural of the last centrum.
Neural of last centrum blunt.
Haemal processes arising on the posterior half of the caudal centra.
Vertebral count: 12 caudal plus 12 trunk. Total 24.

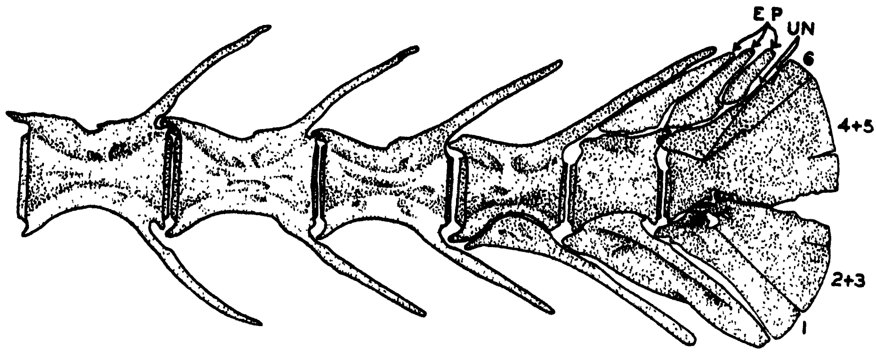
Material Studied.

Length.	*KOH Cat. No.*	*Text-fig. No.*	*Ossification.*
750 mm. (2 spec.).	2117	12	Complete.
503 mm.	598	13	Complete.
115 mm.	2089	14	Complete.

Caudal Osteology.

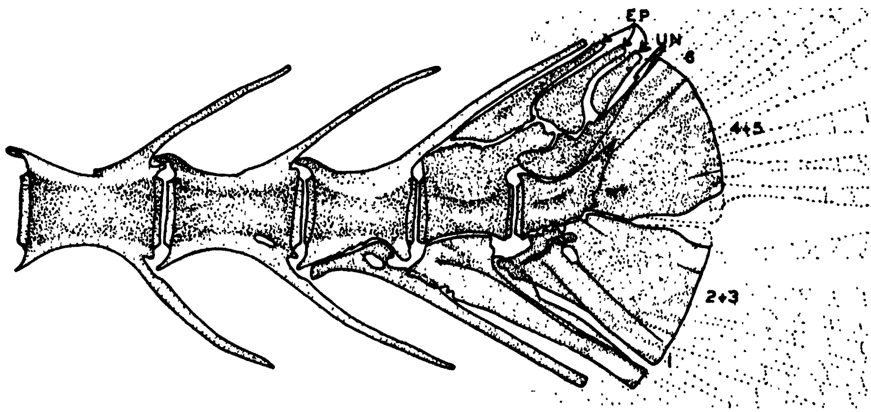
Urostyle: In the 750 mm. specimens, which are the largest in our collection, the urostyle appears completely consolidated with the bases of the 4th and 5th hypurals. On close examination the extremity of the urostyle can be seen as an inconspicuous tip about midway on the surface of the dorsalmost hypural. In the two smaller specimens the complete outline of the urostyle segment can be traced and in the 115 mm. fish it is more elongated, slender and separated from the surrounding bones.

Uroneurals: There are two pairs of uroneurals. Both are easily traced in the 115 mm. fish but the posterior pair is indistinct in the 503 mm. and



Text-figure 12.

Sphyraena barracuda. Tail of 750 mm. specimen showing fused hypurals, urostyle, and uroneurals. (x .8).

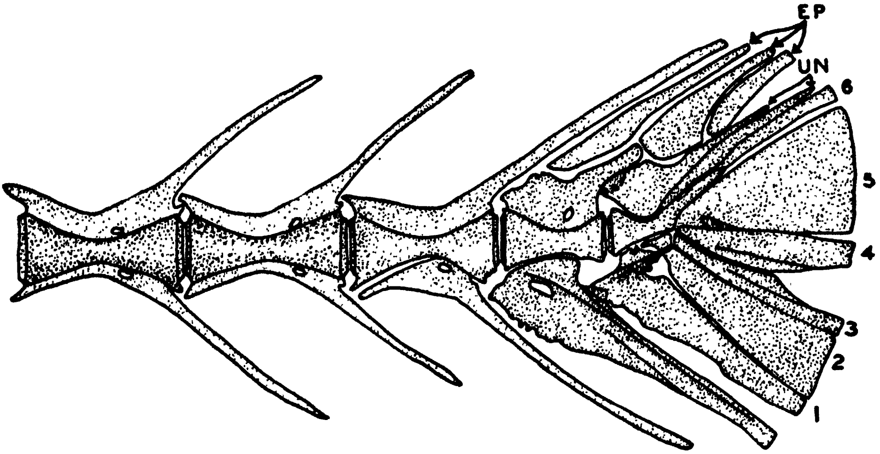


Text-figure 13.

Sphyraena barracuda. Tail of 503 mm. specimen showing only the trace of the urostyle and uroneurals. (x 1.38).

750 mm. specimens. Only the tip is evident near the distal end of the uppermost hypural with which it has become fused.

Hypurals: There are four hypurals, two below and two above the median line in the two largest fishes. But in each specimen a slight cleft is visible near the median line, in both of the large fan-shaped hypurals. In the 115 mm. specimens there are six complete hypurals. The clefts between the hypurals of the larger fishes are all that remain of the two additional



Text-figure 14.

Sphyraena barracuda. Tail of 115 mm. specimen showing form of six hypurals, the urostyle and two pairs of uroneurals. (x 6.5).

bones present in the younger stages. As in *Atherina* and *Mugil* the two median bones are large and fan-shaped.

Epurals: There are three epurals in all four specimens. The three epurals are club-shaped at the base and considerably narrower at their dorsal extremity. The anterior epural is the longest and the posterior one the smallest.

Specialized Neural Processes: The neural process of the terminal posterior centrum is blunt and heavy in form and the posterior neural end is never pointed.

Caudal Fin Ray Count:

750 mm.	10 + 8 = 18	(2 spec.).
	10 + 9 = 19	
503 mm.	7 + 10 = 17	(Text-fig. 13).
	6 + 10 = 16	
115 mm.	9 + 8 = 17	
	9 + 9 = 18	

Additional Characters Worthy of Note: The bases of the posterior caudal haemal arches arise posterior to the center of their respective centra. This is a conspicuous difference from Mugilidae.

2. **Sphyraena borealis** De Kay.

Diagnostic Characters:

The caudal pattern of *Sphyraena borealis* is almost identical with that of *Sphyraena barracuda.* The caudal centra in *S. borealis* are slightly smaller in proportions and the dorsal and ventral raylets are more slender and do not extend as far forward as in *S. barracuda.* Also, the shape of the posterior end of the reduced last neural appears more rounded in all the *S. barracuda* but wider with a square-shaped end in *S. borealis.*

Sphyraena borealis.
Material Studied.

Length.	*KOH Cat. No.*	*Caudal Fin Ray Count.*	*Vertebral Count.*
124 mm.	2087	$\dfrac{8 + 10 = 18}{7 + 9 = 16}$	12 + 12 = 24
114 mm.	2088	$\dfrac{7 + 10 = 17}{5 + 9 = 14}$	
109 mm.	2087	$\dfrac{7 + 11 = 18}{8 + 8 = 16}$	

Sphyraena picudilla.
Material Studied.

260 mm.	515	$\dfrac{7 + 10 = 17}{7 + 10 = 17}$	12 + 12 = 24
230 mm.	514	$\dfrac{8 + 10 = 18}{8 + 9 = 17}$	
120 mm.	2090	$\dfrac{7 + 10 = 17}{5 + 9 = 14}$	

The *Sphyraena picudilla* material which has been studied and considered as one with *S. borealis* is for the sake of clarity listed above in order to show the similarity of two characters, at least, in the vertebral count and the caudal fin ray count.

Summary.

There is a marked similarity in external characters of the species of Atherinidae, Mugilidae, and Sphyraenidae, which are grouped together under the suborder Percesoces, but the study of their skeletons shows that these families are not as closely related as their external similarities indicate. For example, Atherinidae, considered the most primitive of living Percesoces, has a total vertebral count and a caudal count of almost twice the number found in Mugilidae and Sphyraenidae.

According to the caudal osteological pattern, *Atherina* seems to be less specialized and stands apart from the other Bermuda Percesoces. On the other hand Mugilidae and Sphyraenidae are drawn together.

Hypurals: In young specimens of the three families a 3d ventral hypural is present which is directly below the median line and similar in shape and position to the corresponding hypural in all the Bermuda Isospondyli. In the fully adult percesocids this bone becomes one with the 2nd hypural and in all species the pattern is similar in having two large median fan-shaped hypurals. It will be seen in the table that the species of Bermuda Percesoces, including the young, have fewer hypurals than the Bermuda Isospondyli.

Urostyle: In all species of Bermuda Percesoces the urostyle appears consolidated and there is no evidence of separate segments which are found in all of the Bermuda Isospondyli.

Ray-scales: There are no specialized ray-scales. These are prominent in the more generalized Bermuda Isospondyli: *Elops, Tarpon,* and *Albula,* and less obvious in the other Isospondyli.

The table sums up caudal counts and indicates similarities and differences in the species of Percesoces. This opportunity is taken to tabulate the counts of the Isospondyli of Part I for the purpose of comparison.

TABLE I.

Caudal counts, comparing families of Percesoces and the Isospondyli.

Percomorphi	Hypurals.		Uroneurals.	Vertebral Count.	Caudal Fin Ray Count.
Percesoces	Adult.	Young.			
Atherinidae	$4, \frac{2}{2}$	$5, \frac{2}{3}$	1	43 (22 + 21)	$\frac{19}{18}$
Mugilidae	$4, \frac{2}{2}$	$6, \frac{3}{3}$	1	24 (11 + 13)	$\frac{15}{16}$
Sphyraenidae	$4, \frac{2}{2}$	$6, \frac{3}{3}$	2	24 (12 + 12)	$\frac{18}{19}, \frac{17}{16}$
Isospondyli					
Elopidae	$9, \frac{5}{4}$		4	72 to 81 (49to57 + 24to26)	$\frac{18}{16}, \frac{19}{16}$
Megalopidae	$8, \frac{5}{3}$		3	57 (33 + 24)	$\frac{16}{13}, \frac{16}{14}$
Albulidae	$7, \frac{4}{3}$	$7, \frac{4}{3}$	2 adult. 4 young.	69 (42 + 27)	$\frac{18}{16}$
Dussumieriidae	$7, \frac{4}{3}$	$7, \frac{4}{3}$	3	43 (27 + 16)	$\frac{14}{12}$
Engraulidae	$7, \frac{4}{3}$		3	40 to 42 (20to21 + 20to21)	$\frac{18}{17}$
Clupeidae	$7, \frac{4}{3}$		3	37 to 40 (12to14 + 25to26)	$\frac{19}{16}$

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18.

Some Observations on the Feeding Methods of the Vampire Bat.

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(Plates I-III).

Many superstitions and curious beliefs have been associated with the vampire bat. Anaesthetic, depilatory and anti-coagulant properties have been attributed to the saliva of the vampire. Even at this date the true vampires, *Desmodus, Diaemus* and *Diphylla,* are described in dictionaries and encyclopedias as "blood-sucking" animals. In recent years the work of Dunn (1), Clark (2), Urich (3) and Ditmars (4) has done much to afford scientific information as to the habits of the vampire and to discredit erroneous statements as to its behavior.

For the past five years Ditmars has been making a detailed study of *Desmodus rotundus* in New York City. Observation by him in the natural locale of *Desmodus* gave an opportunity for viewing the results of its work. When humans were bitten during the night, blood stains were always apparent. Ditmars reports a case of a ten year old boy bitten during sleep five times within a week. "He had bled profusely and the earthen floor beneath his slatted bed was blood stained each morning." Cattle frequently showed large blood stains on their hides. "Ropes" of coagulated blood were seen hanging from the necks of horses attacked in their stalls. Such observations were indicative of profuse bleeding. The possibility that saliva of the vampire bat contained an anti-coagulant which might be used for studying some aspects of the phenomena of blood coagulation seemed worthy of consideration. It is well known that certain of the hematophages secrete such substances.

Bier (5), in 1932, reported a fibrinolytic and anti-coagulant action of an alkaline alcohol-ether extract of macerated salivary gland of *Desmodus.* He states that a similar extract of the salivary glands of a single specimen of *Phyllostoma* did not reveal such properties. Bier states that aqueous extracts of the glands of *Desmodus* had no anti-coagulant properties. Samples of rabbit blood to which the aqueous extract were added showed the same coagulation time as the control samples. This does not appear to afford a strong evidence for the implied significance of his observations.

During the preparation of this article the attention of the authors was called to a paper by Pawan (6) in which he states: "Bleeding may be profuse, probably due to an anti-coagulant, which was found present in both the dry and fresh powdered salivary gland substance, and which is capable of hindering coagulation of human blood in greater dilution than 1 in 1,000." Pawan does not give the details of preparation of this extract.

An opportunity for further observation on the method of feeding was made possible by the availability of four specimens of *Desmodus* at the New

York Zoological Park. Four additional specimens were obtained from Trinidad for the investigation of the possible anti-coagulant properties of their saliva, through the kindness of Professor Urich.

The vampires were housed in a large cage, well protected from drafts, without any special attention to maintenance of a constant temperature. The cage was kept scrupulously clean. A fresh supply of drinking water was constantly at hand. The bats were fed defibrinated blood two or three times a week. On the remaining days, except on Sundays when they were starved, they were allowed to feed upon either live fowl, rabbits, guinea pigs or a goat. There was ample room in the cage to permit putting the various animals in with the bats, and yet allow the bats sufficient space to take flight and attain a safe roost if their host became restless.

In order to determine whether an anti-coagulant was normally present in the saliva of *Desmodus* while it was feeding, (1) coagulation time was determined for samples of blood from the bat wounds, (2) the bleeding time of the wounds was noted, (3) the effect of washings from the bats' mouths was tested on freshly drawn cat's blood and (4) the mouths of the bats were examined for clots following the feeding of human blood by means of an eye-dropper.

Method of Obtaining Samples for Determination of Coagulation Time.

The method of presenting the experimental animal to the bats varied for the species. Where fowl were used the initial practice was to bind the wings and legs. The movements of rabbits and guinea pigs were restricted by bandaging them to an animal board. A halter was placed on the goat to prevent it from throwing its head back and injuring the bats with its horns.

It soon became apparent, however, that the vampires were well able to take care of themselves. They were able, in all except a few instances, to bite and feed without disturbing their hosts. Fowl were completely indifferent to their enforced role so that the binding was soon discontinued. In one instance when feeding was interrupted by turning on the light, a rooster got on its feet and walked a few steps, while a bat, standing on its hind legs, its thumbs braced against the leg of the rooster, continued to lap blood from the wound. The goat displayed some curiosity as to the bats when they were moving about, but showed no indication of being aware of being bitten. Occasionally, during the feeding, the goat would contract its panniculus carnosus muscle, causing its hide to quiver, as it might do to shake off flies. Since rabbits and guinea pigs are fairly active in the dark, it was deemed advisable to continue restricting their movements.

After placing the host in the bat cage, the lights were extinguished and a sufficient time was allowed for the bats to get under way with their feeding. Feeding was then interrupted and the animal removed from the cage. An attempt was then made to secure a sample of freely flowing blood either in a small phial or in a capillary tube such as is ordinarily used for determination of coagulation time.

At the outset, it was apparent that the presence of an anti-coagulant would be indicated only if coagulation were delayed for relatively long periods. The experimental conditions were far from ideal. The wounds were frequently contaminated with hair and other foreign material during the process of feeding. In addition there was considerable unavoidable variation between the actual time of the bite, which could not be accurately determined, and the time of collecting the samples. Control experiments for comparison of coagulation time could be of only minor significance since the bites could not be adequately imitated.

Fowl.

The results on fowl were equivocal. All but one of the samples of blood taken from two fowl clotted in 3 to 7 minutes. Blood from a wound made by cutting a small crater with a scalpel clotted in 2 to 6 minutes. One sample from the bat wound did not clot for 50 minutes. Such a result might indicate either that there was a sufficient quantity of active saliva to retard coagulation in only one sample or that there was something unusual in that sample. Blood of fowls does not contain cephalin, and clotting depends upon the addition of tissue cephalin so that there exists the possibility of obtaining samples without "contamination" of the tissue fluid. The use of fowls was discontinued for this type of test so as to rule out such a possibility.

The results of observations made on other species are summarized in Table I.

TABLE I.

Range of coagulation times for the samples of guinea pig, rabbit and goat blood.

Animal.	No. of Animals.	No. of Experiments.	No. of Samples.	Source of Samples.	Range of Coagulation times (Min.).
Guinea Pig.	1	1	5	Incised marginal ear vein.	4-5
			3	Bat wounds.	3-8
Rabbit.	2	2	10	Incised marginal ear vein.	3-10
			6	Bat wounds.	3-10
			1	From blood dripping on wax paper from incision on toe.	5-17
			1	From blood on wax paper from bat wound.	9-20
Goat.	1	3	19	From bat wounds.	1-10

A typical protocol of a test on the goat is given below.

7 P.M. Goat placed in cage; lights extinguished.

9:40 P.M. Feeding interrupted. Two bats were seen feeding on the goat. One old wound on its side had been reopened. Another fresh wound had been made on its back. The old wound was oozing blood; the wound on the back was relatively clean and dry with only a minute amount of blood in the crater-like wound. Samples were taken from site of old wound.

Sample.	*Clotting Time.*
1	3'45"
2	3'50"
3	6'45"
4	6'20"
5	5'17"
6	5'01"
7	3'50"
8	3'50"

10 P.M. Wound on back showed small amounts of clot around edges of crater; no bleeding. The wound was opened by gentle massage of the surrounding area.

Sample.	*Clotting Time.*
1	2′
2	1′10″

After the bats had been feeding, small pools of blood were seen on the floor of the cage; frequently the pelage of the host was streaked with blood. In spite of the evidence of a free flow of blood during feeding, the efforts to obtain adequate blood samples for determination of coagulation time were frequently unsuccessful. On removing the animal from the cage the wounds were usually either relatively dry or showed a slow oozing which filled the crater of the bite, but did not drip from the wound. Occasionally, however, the oozing was sufficient to result in some dripping.

When the flow was inadequate for sampling, gentle massage around the area of the wound would reestablish a slight flow. Clots formed, in the undisturbed wounds and in wounds in which the flow had been reestablished by massage, in 4 to 35 minutes.

In contrast to these results, a wound, inflicted by inducing a leech to feed on the goat, bled for more than an hour. Samples collected from the leech wound showed coagulation times of 7 to 13 minutes.

The Effects of Washings from the Mouths of *Desmodus* on Coagulation Time of Cat's Blood.

After repeated handling the bats would remain quiet when held lightly in a gloved hand. Occasionally they would bite the glove once or twice and then become quiet and feed contentedly from a pipette. When they had become accustomed to handling, washings were obtained from their mouths with the view that if an anti-coagulant were present, it might be possible to obtain a solution of their saliva of sufficient concentration to retard or prevent coagulation of freshly drawn blood.

5 cc. of distilled water was measured into a small container. A few drops were taken up in an eye-dropper and injected into the mouth of a bat. The washings were recovered from the mouth or the lips, returned to the original 5 cc. container and the dropper rinsed in the mixture. The process was repeated six to ten times for each of the four bats. A half-hour

TABLE II.

Coagulation time: cat's blood (carotid artery) and washings from mouths of *Desmodus*.

Sample.	CC. of Blood.	Solution Added.	Am't Solution.	Coagulation Time.
1	3	Saline "washings."	5 drops	4′28″
2	3	" "	3 "	3′33″
3	3	" "	1 "	3′50″
4	3	Distilled Water "Washings."	5 "	2′31″
5	3	Distilled Water "Washings."	1 "	4′53″
6	3	Saline only.	5 "	5′03″
7	3	" "	1 "	6′47″
8	3	NONE (clean & dry).	......	5′51″
9	3	" " "	......	6′08″

rest period was allowed and the process was repeated, using 5 cc. of saline solution. Small portions of the 5 cc. of saline washings and the 5 cc. of distilled water washings were added to 3 cc. of freshly drawn cat's blood. Coagulation time was taken when the test tubes could be inverted without spilling the mixture. The results are summarized in Table II. It is apparent that the addition of washings decreased the coagulation time. Similar results have been obtained with human and dog saliva, by Bellis, Birnbaum and Scott (7). Human saliva reduced coagulation time when added to blood in proportions of 1 to 400.

Results of Examination of the Mouths of *Desmodus* after Feeding Freshly Drawn Blood with Pipettes.

To obtain freshly drawn blood for the feedings, the fingers of one of the observers were washed thoroughly with soap and water and then alcohol. Time was allowed for the fingers to dry and a puncture was made with a blood lancet to a depth to permit a generous flow of blood. A portion of the blood was drawn into a clean dropper and transferred to the mouth of a bat. If the bat fed rapidly, two or three portions could be transferred to the bat's mouth in about a half a minute. A clean dropper was then taken, a fresh puncture was made and the process was repeated. The mouths of the bats were forced open gently at frequent intervals and examined for clots.

Results: April 17. Pipetted blood from finger puncture into mouth of bat. Surface of finger was repeatedly cleaned, using a new drop of blood and a clean pipette after 2 or 3 feedings. Bat's mouth gently forced open with forceps. Several small clots were noted and removed.

May 4. Male bat fed on blood from finger punctures. No clots were seen on examination of buccal cavity. A small clot was allowed to form on a finger puncture and was offered to the bat. He ate it readily.

Female—Did not feed well. Only occasional movement of tongue. Swallowing infrequent. As a result some blood collected in mouth. Examination revealed some fluid blood in the rugae palatinae. Small clots were seen on the tongue, hard palate and on the buccal surfaces of the cheeks.

May 10. Male—Fed blood from finger puncture. Examination revealed small clots in mouth.

May 15. Male—Fed blood from finger puncture. Examination revealed good clot after first 3 feedings (less than 1 minute).

Female—Fed for 3 minutes. Clot seen in mouth.

May 20. Two bats fed on blood from finger puncture. Clots seen in mouths after feeding.

Depth of the Bat Bites.

Tissues surrounding wounds at which bats had been feeding were removed and fixed for sectioning and histological examination. Sections were made of the wounds in a pigeon, a chicken and a guinea pig.

The bite in the guinea pig extended through the four layers of the epidermis and the two layers of the dermis but did not involve the panniculus adiposus. Thus, the bite may be said to be skin deep.

The combined thickness of the dermal and epidermal layers in the guinea pig are from two to four times as thick as they are in the pigeon. The panniculus adiposus in the guinea pig was of a fairly constant depth but in the pigeon it was variable although always present in some degree. In the pigeon the panniculus adiposus and even a few of the outermost muscle bundles were removed. Although a greater number of differentiated

layers were removed in the pigeon, the bite was of approximately the same depth as in the guinea pig.

The bite in the chicken extended into the stratum reticularis of the dermis. As the dermis of the chicken in that area was thicker than that of either the guinea pig or the pigeon, a bite of approximately the same depth did not reach the adipose layer.

CONCLUSIONS.

While it has been reported that extracts of the salivary glands of *Desmodus* have anti-coagulant properties, the results of these experiments fail to reveal any evidence that an anti-coagulant plays a part in the normal feeding process of the vampire. The difficulty in obtaining adequate samples of the blood, the relatively rapid clot formation in the wounds after feeding has been interrupted, and the presence of clots in the mouths after dropper feedings, are strong indications that the rapid flow of blood during feeding is due to the nature of the bite and the massage by the tongue.

The view that since vampire bats are hematophages they are supplied with a saliva having anti-coagulant action may have arisen through teleological reasoning. Slicing the highly vascular dermis insures a fairly good flow of blood. If the flow is free, the bat laps the blood scarcely touching the tissues; if scant, the bat licks the wounds (1). The blood stains on the pelage and on the ground may be accounted for by dripping of the wound when the flow is kept going during the feeding.

Acknowledgement is due Dr. R. L. Ditmars for his whole-hearted cooperation in carrying out these studies. Dr. Ditmars offered his own specimens of *Desmodus rotundus* for the preliminary observations in which he collaborated; he assisted in helping obtain the additional specimens from Trinidad and made many helpful suggestions as to their handling and care. The authors also wish to express their indebtedness to Professor Ernest L. Scott for the photographs and to Mr. William Bridges for his encouragement and helpful suggestions.

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EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. Training a vampire bat to feed from a medicine dropper, using defibrinated blood. The bat is held lightly between the thumb and the first two fingers.

Fig. 2. The bat feeds contentedly from the dropper. It may be noted that the mouth is open and the lips are not in contact with the pipette. The tip of the tongue may be seen touching the end of the dropper.

PLATE II.

Fig. 3. Lapping blood from the site of a blood puncture. The bat evidences no annoyance at the handling. All his efforts are directed toward obtaining the blood.

Fig. 4. Finishing the drop of blood. The spear-shaped tongue is well extended in lapping the blood.

PLATE III.

Fig. 5. Microphotograph of a vampire bat bite in the guinea pig. The bite extended through the epidermis and the dermis.

Fig. 6. Microphotograph of a bite in the pigeon. The epidermis, dermis, panniculus adiposus and even a few of the outermost muscle bundles were removed.

FIG. 1.

FIG. 2.

SOME OBSERVATIONS ON THE FEEDING METHODS OF THE VAMPIRE BAT.

FIG. 3.

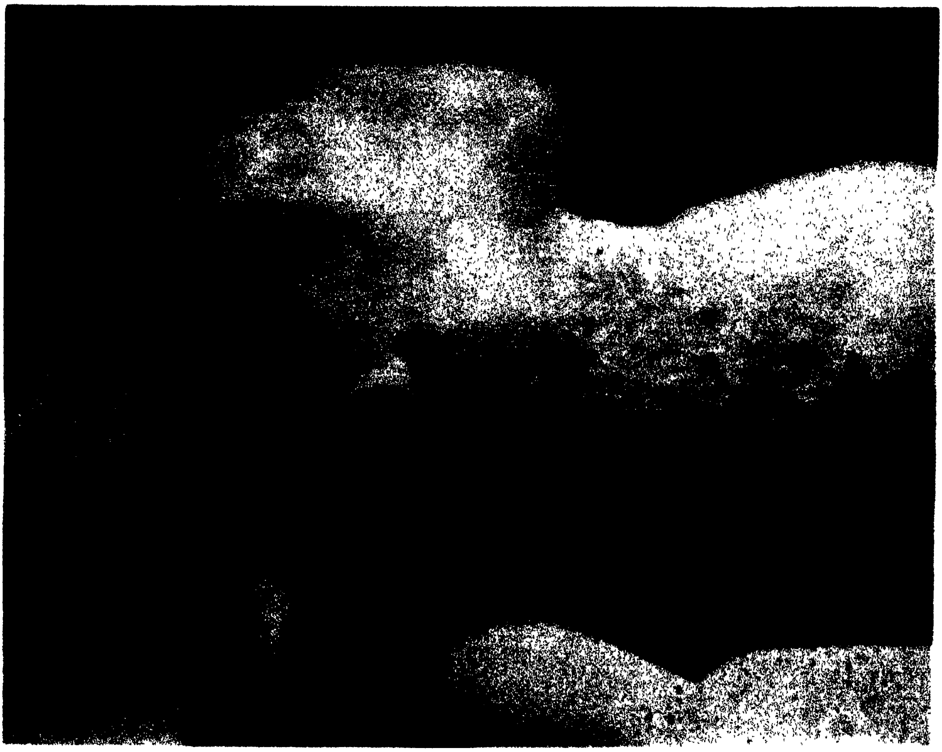

FIG. 4.

SOME OBSERVATIONS ON THE FEEDING METHODS OF THE VAMPIRE BAT.

FIG. 5.

FIG. 6.

SOME OBSERVATIONS ON THE FEEDING METHODS OF THE VAMPIRE BAT.

19.

Growth of Galápagos Tortoises, *Testudo vicina,* from 1928 to 1937.

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(Plate I).

The colonies of Galápagos tortoises (*Testudo vicina*) established by the writer under the auspices of the New York Zoological Society may be reported as in prosperous condition. The tortoises are now in eight groups. Those within the limits of the United States were originally a little more widely distributed.

During the nine years they have been under our observation, the animals have made notable growth. When distributed for observation in 1928, the average weight of the 100 tortoises considered in this paper was a little more than 18 pounds. At present it is more than 134 pounds. A dozen individuals weigh nearly 200 pounds each, and a score weigh more than 160 pounds.

In the table showing growth we have not included all the tortoises originally reported upon (see *Zoologica,* Vol. IX, No. 13; June 1, 1931). A few lost the copper numbers used to identify them, and a few are temporarily out of reach. The 100 herein reported upon have individual records without error.

TABLE I.

Growth of *Testudo vicina* at all stations.

Place.	Number of Tortoises.	Total lbs., 1928.	Average lbs., 1928.	Total lbs., 1937.	Average lbs., 1937.
San Diego, Cal.	18	425	23.61	2,492	138.44
San Antonio, Tex.	7	99	14.14	1,078	154.00
Houston, Tex.	8	72	9.00	1,312	164.00
New Orleans, La.	7	100	14.28	1,010	144.28
N. Miami, Fla.	39	908	23.28	5,305	136.02
Bermuda	9	56	6.22	864	96.00
Honolulu, T. H.	6	177	29.50	1,129	188.16
Sydney, Australia	6	19	3.16	306	51.00
	100	1,856		13,496	

Being widely scattered, the tortoises have not all been treated alike. Their food has varied somewhat from place to place, and some have still to be housed in winter. There were losses from feeding vegetables on sandy ground, post-mortem examinations showing sand impacted in the colon.

The following records made at Houston, Texas, for the years 1928 and 1936 show the growth in dimensions as well as weight.

TABLE II.

Increase in dimensions and weight of eight *Testudo vicina* at Houston, Texas, between 1928 and 1936.

1928.

No.	Length, Inches.		Width, Inches.		Height. Inches.	Weight, lbs. 1928.
	Straight.	Curved.	Straight.	Curved.		
90	13⅛	17½	11	17¼	7¼	13
91	12½	15¾	9½	14⅝	5⅞	10
92	11⅛	14½	8½	13¼	5¼	7
93	12	15¾	9¼	14¾	6	8
94	11¾	14⅝	8⅞	14	5⅝	7
95	12¼	15½	9½	15	6	10
98	10¾	13½	8½	13	5⅛	7
99	12½	15¾	9⅝	15¼	6⅛	10
						72

1936.

No.	Length, Inches.		Width, Inches.		Height. Inches.	Weight, lbs. 1936.
	Straight.	Curved.	Straight.	Curved.		
90	25	40	27	40	20	179
91	24	38	24	40	20	154
92	23	35	21	38	19	150
93	23	35½	22	38	19	149
94	23½	37	22½	39½	19¾	162
95	24	38	24	38	19	155
98	24	41	26	42	21	183
99	25	40	24	41	20½	180
						1,312

The tortoises housed in winter, and uniformly dark-colored, developed very rapidly a conspicuous white growth-ring on the border of each horny plate when turned out on grass. This treatment produced a new ring each year, indicating age; growth slow in winter, rapid in summer. Tortoises in southern Florida, having access to grassy ranges at all times, were never lacking a very faint whitish ring. However, tortoises of similar size and weight had equal numbers of rings, regardless of treatment. For photographs of growth rings, see *Zoologica,* Vol. IX, No. 13, page 469.

The horny plates of the tortoises expand with the growth of the animal, by adding rings of new material around their margins.

In the younger animals, at least, age is indicated by number of rings. In tortoises of large size the rings tend to flatten and are hard to count. At-

tempts at counting rings on tortoises exceeding 160 pounds in weight indicate that they are about 20 years old. All males of that size or a little over have within the past three years partly acquired the concave plastron that *must* precede breeding age. This hollowing out is still increasing and we assume that maturity is near. Giant tortoises are long-lived. There are records of a few that exceeded 150 years. The breeding age may not be attained until they are between 20 and 25 years old.

EXPLANATION OF THE PLATE.

Plate I.

Fig. 1. *Testudo vicina.* Specimen No. 10 at North Miami, Florida. Weight, 165 pounds. As nearly as can be judged by ring growth, this tortoise is about 20 years old and the hollowing of the plastron, indicating an approach to breeding age, is quite noticeable.

FIG. 1.

GROWTH OF GALÁPAGOS TORTOISES, TESTUDO VICINA, FROM 1928 TO 1937.

20.

Lymphocystis Disease in *Angelichthys.*

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&

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(Plates I-III).

A cutaneous disease in fishes, particularly in flounders, characterized by the formation of small, irregular, solitary or confluent nodules of grayish-white color has been studied by a number of investigators (Woodcock, 1904; Awerinzew, 1909; Weissenberg, 1914; Benisch, 1937). Earlier studies indicated that this peculiar disease in fishes was caused by some form of *Cnidosporidia.* More recent studies tend toward an explanation that an unknown virus may be the principal causative factor (Weissenberg, 1914; Benisch, 1937). The small nodules forming the visible features of the disease lie directly below the epithelium of the skin. Histologically the lesions exhibit an immense hypertrophy of individual cells of the host. Hypertrophied cells may show a diameter many times the normal. The cytoplasm of such cells is surrounded by a dense cell membrane. The cell nucleus is also enlarged and stains paler than normal. Cell inclusions of various sizes, shape, and arrangement can be demonstrated in the cytoplasm, and these are regarded as the evidence of the activity of a living though invisible virus which has initiated striking structural changes in the cells.

Two instances of lymphocystis disease occurring in the adult common angelfish (*Angelichthys isabelita*) have come under observation recently at the New York Aquarium. These fishes occupied a large salt-water tank with about ten other angelfishes of the same species. The victims of the disease were apparently in good health at the time they were received at the Aquarium, and it is our impression that the onset of the infection took place during the period of their captivity.

On inspection both angelfishes presented numerous dark grayish patches and nodules on the surface of the skin, most conspicuous in the region of the base of fins and at the base of the tail. In some areas the individual nodules were as much as one and one-half centimeters in diameter. Plate I, Figure 1, shows one of these nodules, somewhat enlarged, which was removed for biopsy from the region of the dorsal fin, and in the photograph the mass is seen as attached to one of the rays of this fin. Plate I, Figure 2, shows the same specimen cleared in cedar oil, which permits a transillumination of the specimen, in order to show the small pin-point black dots covering the surface of the tumor and often giving it a dark hue. Each black dot represents a single or a group of corial melanophore cells of the

skin overlying the growth. On cross-section of the tumor, the tissue is found to be grayish-white in color, and very soft. The nodules are confined strictly to the skin, and do not invade the deeper lying muscles. The tumor tissues removed for biopsy were preserved in 10% formalin, and the sections were prepared by the paraffin method. The stains employed were eosin and methylin blue and hematoxylin and eosin. It is realized that other forms of fixation and staining will have to be used in future studies, in order to insure a more satisfactory analysis of cytological detail, particularly from the standpoint of cell inclusions.

Plate II, Figure 3, and Plate III, Figure 5, are the photomicrographs of the structure of one of the skin nodules. The overlying epithelium is considerably thickened and hyperplastic, attaining a depth of from fifteen to twenty cells. Numerous mucous cells are found in the epithelium, and in some fields they are greatly distended, almost cystic in appearance. Below the epithelium lies a thickened corium, containing scattered melanophores. It is just below this point that the characteristic lesion of lymphocystis disease becomes apparent. The tissue here assumes the appearance of a spongy network of fibrous compartments containing hypertrophied cells varying greatly in size and contour. These enormous cells (Plate II, Figure 4, and Plate III, Figure 6) lie in a thickened tissue framework composed of elongated connective tissue cells, at times hyaline in appearance. The hypertrophied cells contain a fine granular cytoplasm with some basophilic material at the periphery. In many sections cut at the proper level, a pale-staining nucleus with one or two nucleoli can be distinguished. The larger cells, measuring often as much as 468 microns, show irregular and pale nuclei with beaded and festooned chromatin collections at the periphery. Of great interest was the finding of bright-staining eosinophilic hyaline-like bodies in some of these distorted nuclei. Such red-staining intranuclear masses resemble inclusion bodies characteristic of certain virus diseases. Further studies with different fixations and staining technique will be necessary to determine this point. Where the fixation of the tissues has been uniform and satisfactory, it is seen that the largely hypertrophied cell has a distinctly thickened cell membrane. In many areas the cytoplasm of large diseased cells has shrunk away from its surrounding fibrous structures.

An impression is gained that a low grade inflammation accompanies this hypertrophic process affecting the cells of the host, as there are many collections of lymphocytes in the various microscopic fields examined, such as is seen for example in Plate III, Figure 5.

SUMMARY.

Lymphocystis disease occurring in the angelfish (*Angelichthys isabelita*) is described, and structural arrangement of the characteristic cutaneous nodules is discussed.

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EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. A nodule of lymphocystis tissue removed for biopsy, enlarged eight times. It is attached to a fragment of the dorsal fin ray.

Fig. 2. The same nodule, slightly lower magnification, cleared in cedar oil, transilluminated to show the minute black dots representing melanophore cells of the skin overlying the tumor. x 7.

PLATE II.

Fig. 3. Section of spongy network of lymphocystis disease lying below thickened epithelium. Hypertrophic cells are seen lying in fibrous tissue compartments. x 65.

Fig. 4. A single hypertrophied cell. x 250.

PLATE III.

Figs. 5 and 6. Hypertrophied lymphocystis cells. x 125.

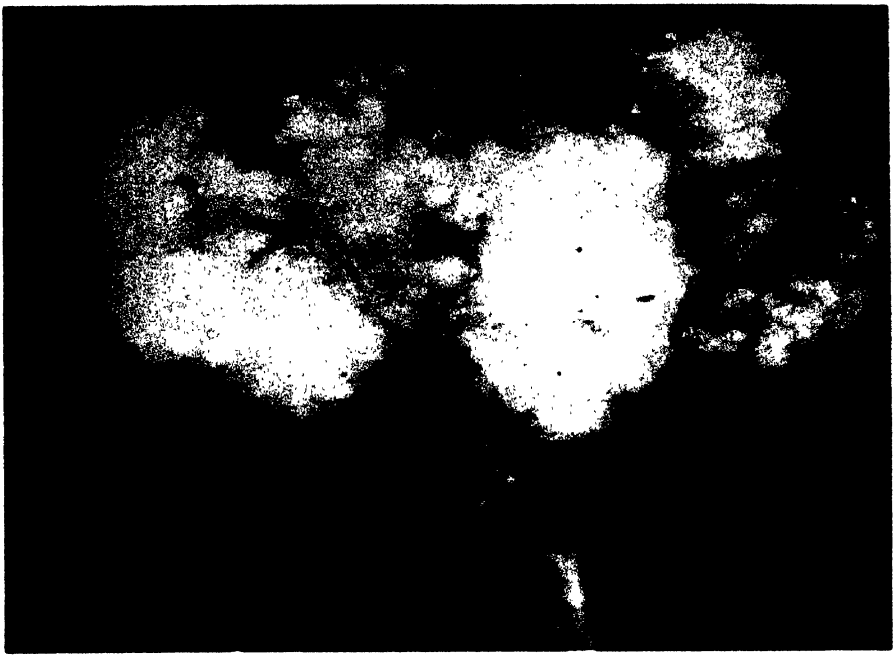

FIG. 1.

FIG. 2.

LYMPHOCYSTIS DISEASE IN ANGELICHTHYS.

FIG. 3.

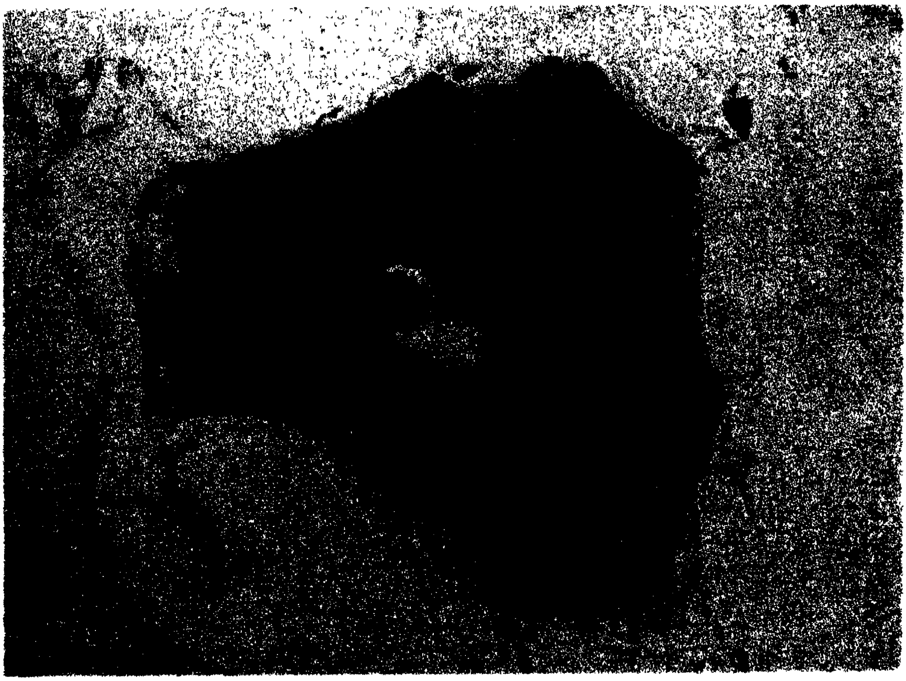

FIG. 4.

LYMPHOCYSTIS DISEASE IN ANGELICHTHYS.

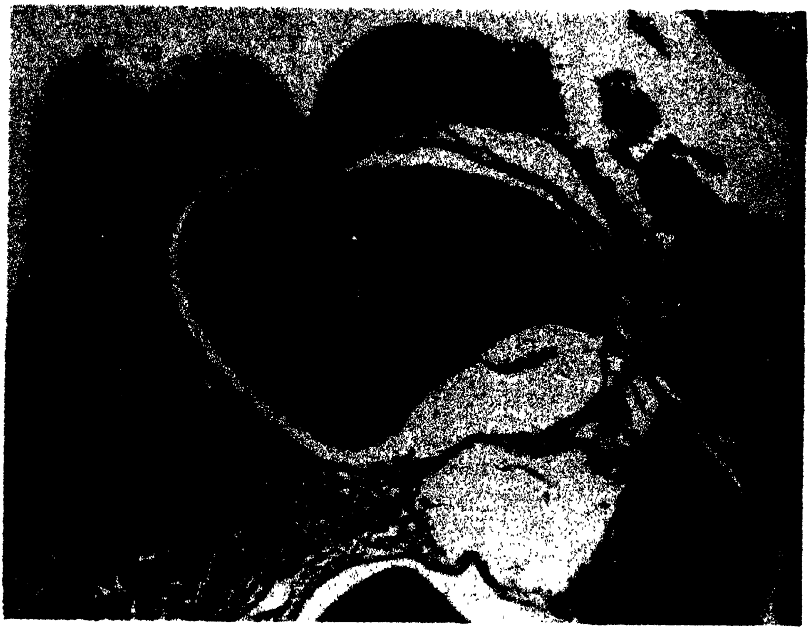

FIG. 5.

FIG. 6.

LYMPHOCYSTIS DISEASE IN ANGELICHTHYS.

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CONTENTS

21.

The Histological Structure of the Normal and the Hyperplastic Thyroid in *Rasbora lateristriata* (Bleeker).

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&
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(Plates I-III).

In an earlier publication (Smith, Coates & Strong) it was noted that hyperplastic conditions of the thyroid among small tropical fishes of the New York Aquarium occurred only in rare instances. Among approximately 400 species there were two examples of thyroid growths in the course of a period of observation lasting five years. These conspicuously enlarged goitres occurred in *Rasbora lateristriata* (Bleeker) and in *Heterandria formosa* Agassiz. They were sporadic forms of the disease and progressive in nature. Death occurred between six and eight weeks after the thyroid tumors were first observed. In order to study in greater detail the alterations in the diseased thyroid, a complete serial section of the entire head of a specimen of *Rasbora lateristriata* with thyroid hyperplasia has since been made. In addition, complete serial sections of four normal adult fishes of the same species, two male and two female, were prepared for purpose of comparison. The histologic observations on the normal and the hyperplastic thyroids are recorded and illustrated in the present paper.

A large part of the thyroid studies in fishes has been done on the Salmonidae, as these fishes are subject at times to a diseased enlargement of this gland, usually in the form of a benign hyperplasia, yet occasionally showing morphologic changes suggesting malignancy. A number of years ago, Gudernatsch (1911) described the normal structure of the thyroid gland in twenty-nine species of teleosts. By a systematic comparison of all these species this author found that there exists a wide variation in the thyroid gland of fishes, with a continuous series of transitions from one form to another. The thyroid gland of fishes, often invisible to the eye, is usually detected by microscopic examination. The actual position of the thyroid gland is described by Gudernatsch as lying below the floor of the pharynx, in the body of the tongue, between the gill arches, extending posteriorly near the origin of the third and fourth branchial arteries as they arise from the ventral aorta. The paired muscles of the sterno-hyoideus extend below the gland, while above the gland lie the bony and soft parts of the floor of the pharynx. The thyroid, therefore, lies in a relatively closed compartment whose separate structures are subject to con-

siderable variation. It is not surprising that the thyroid tissue itself was found to possess differences in size and distribution in individuals of the same species. For example, Gudernatsch found that in twelve weak-fish (*Cynoscion*), all differed in the extent and position of their respective thyroids.

It is well known that the thyroid gland of fishes cannot be regarded as a solid compact encapsulated organ as in higher vertebrates, but rather as a collection or grouping of follicles. The more densely arranged follicles lie in the neighborhood of the aorta or the branchial arteries particularly where these branches arise from the aortic stem. In Gudernatsch's studies, the thyroid follicles were most abundant in the region of the second gill arteries. The roots of the last gill branches seemed to have the least number of follicles. Usually the thyroid tissue lies ventral to the aorta, yet in some fishes dense clusters of follicles are located both dorsal and ventral to the aorta. Near the periphery, follicles are more commonly scattered in their arrangement.

It is of considerable anatomic interest that thyroid tissue in fishes follows a distribution along the main blood channels running between the heart and the respiratory tissue of the gills. It is believed that in the fish embryo, thyroid tissue lying originally between the first and the second gill branches later in development migrates in caudal, cephalic, and lateral directions to assume various other new yet permanent positions along the region of the aorta. This embryological migratory tendency along blood vessels exhibited by thyroid tissue may account for certain displaced thyroid follicles being found later in life in the domain of the more distant blood vessels of the gills. Such a distribution is not at all uncommon in the case of the trout under apparently normal conditions. The finding of normal thyroid tissue in the gills has offered considerable difficulty in interpreting the meaning of the larger hyperplastic thyroid masses involving gill structures when the thyroid gland as a whole responds to a stimulus causing a diffuse overgrowth.

At the time of Gudernatsch's paper on the normal thyroid in teleosts, a great deal of interest was manifest in the enlarged thyroid or goitre occurring in the trout. This disease made its appearance in this country and in Europe in epidemic and sporadic form. The lesions of fish goitre were extensively studied by Gaylord and Marsh (1914), Marine and Lehnhart (1910), Plehn (1902), Pick (1905), Pick and Poll (1903). The gross lesion makes its appearance as a pinkish globular swelling below the floor of the mouth, and later as a conspicuous swelling on the ventral surface in the region of the gills. Such goitres were known to regress, yet at times they showed a progressive course with a fatal issue. Various causative factors were suggested as important in their production, such as dietetic insufficiencies, lack of iodine, undetermined bacterial or virus infection from sluggish or contaminated water. As the disease in some of the fishes, as already stated, proved to be a progressive one and the goitre became a conspicuous tumor at times involving, microscopically, cartilage, bone, muscle or epithelium, some investigators attributed neoplastic features to this atypical form of growth, and the term "so-called carcinoma of the thyroid" came into descriptive use. It was pointed out that such thyroid tumors remained strictly localized. The few instances of associated isolated secondary growths described for the mandibular, gill or anal region, could be interpreted as embryologically displaced thyroid tissue in a state of hyperplasia. The evidence now points to the fact that nearly all types of fish tumors remain localized, irrespective of the histological characteristics, or the organ involved, and that secondary growths or metastases do not occur with the frequency among fishes that they do in the case of tumors in birds and mammals.

In our own investigation of the thyroid in *Rasbora lateristriata*, comprising four normal fishes, two male and two female, and the one case of thyroid hyperplasia, the entire head was fixed in 10 percent. formalin, and after decalcification, serial sections were prepared by the paraffin method. The stain used was hematoxylin and eosin.

The normal thyroid gland of this small "tropical fish" measuring about 3 cm. is invisible to the naked eye, but can be definitely located microscopically in the region anterior to the heart in close relation to the aorta. As is usual in the teleost, thyroid tissue does not form a compact gland. It consists in this fish of a very few small follicles, about 10 to 12 in number, strung along the main vascular trunk or its immediate branches. (Plate I, Figs. 1-4). The follicles are complete and do not communicate with each other. They are oval or circular in cross section and contain a small amount of eosinophilic staining colloid material, in places shrunken away from the lining epithelium as a result of the action of the fixative. The epithelium is a delicate one of a very low columnar or flattened type. The cytoplasm is clear, at times slightly vacuolated, while the nucleus of the cell is round or oval and not deeply stained. The epithelium is supported by fine fibrillar connective tissue showing here and there a narrow elongated nucleus. This fine fibrous tissue may send out processes uniting follicles to each other or to the extremely thin wall of adjacent blood vessels. No colloid droplets are visible in the epithelium or neighboring tissue spaces, blood, or lymph vessels. The larger thyroid follicles measure from 50 to 90 microns in diameter. There seem to be no clusters or nests of thyroid epithelium. No clues are suggested as to the manner of growth or regression of the thyroid follicle in this small fish. A few small blood vessels are found near thyroid tissue and an occasional small nerve trunk. No thyroid tissue was distributed in the substance of the gills. There was no essential difference between the male and the female thyroid.

Contrasting with the normal thyroid tissue, the hyperplastic thyroid growth offered a wide difference in appearance and distribution of its structural elements. The thyroid tumor itself measures 2.5 mm. in diameter, whereas the thyroid follicles in the normal fish occupy an area estimated as not much more than .1 mm. The goitre forms a somewhat irregular-shaped mass without a capsule. (Plate II, Fig. 5). The mass is composed in part of small compact thyroid follicles, in part of a diffuse continuous collection of larger follicles in various stages of distention with colloid. (Plate II, Fig. 6). The largest follicles measure as much as 550 x 190 microns. A rough estimate indicated that in the normal fish not more than 10 follicles were present in a cross section, whereas the thyroid tumor possessed perhaps as many as 3,000 follicles in a transverse section through its widest diameters. In the most compact part of the tumor, epithelial cells are very small with a small light-staining nucleus, while follicles distended with colloid are lined by very low columnar or flat cells. The irregular infolding of epithelium seen in human exophthalmic goitre is not present. Occasionally there is a papillary fold of epithelium supported by a delicate core of connective tissue which projects from the wall of a distended or cystic follicle into the colloid containing lumen. There are a few places where a point of communication exists between two adjacent cystic follicles (Plate III, Fig. 12). The rule is that where follicles are once formed, they remain globular and complete without any evidence of branching. For the most part follicles lie in contact, with a small amount of very fine connective tissue interposed. There is no evidence of fibrosis.

Whereas in the normal fish lymphoid cells are practically absent, in the hyperplastic specimen scattered collections of lymphoid cells are not uncommon. Such areas of lymphoid cells suggest the existence of an associated mild chronic inflammation. We found no inclusion bodies either nuclear or cytoplasmic.

Conspicuous in the diseased thyroid is the greatly increased vascularity. In all parts of the thyroid tumor are found small deeply engorged veins, representing a blood supply greatly increased over the normal. (Plate II. Fig. 6). There appeared to be no evidence that lymphatic vessels were correspondingly increased in number. The thyroid tumor does not show sufficient mitoses to indicate a rapid growth, nor are there changes suggesting degenerative processes or actual necrosis.

Infiltration of muscles, cartilage and bone is frequently encountered. (Plate III, Figs. 9, 10). The destructive assault upon gill tissues is particularly noteworthy (Plate II, Figs. 7, 8), as in the normal fishes no traces of thyroid tissue could be identified as occupying gill structures. In the caudal direction, the thyroid mass encroaches on the aorta near the heart (Plate III, Fig. 11). Here as in the gills, mechanical pressure caused by the thyroid mass might seriously impair the function of important vascular structures. It seems extremely doubtful that with such advanced replacement of gill tissues a complete regression and restoration to normal could be expected even if the necessary physiological conditions were ever re-established as, for example, by the experimental supply of sufficient iodine. Whether or no destructive invasion of normal tissues associated with the advancing thyroid growth represents in any sense a low grade of neoplasia is a matter of individual interpretation. Further studies of sporadic forms of thyroid growth in these small fishes would help to determine this point.

SUMMARY.

The histology of the normal thyroid of *Rasbora lateristriata* is described and contrasted with an instance of massive hyperplasia of the thyroid occurring in the same species. The disease of the thyroid occurred in sporadic form. It was progressive and fatal in the course of two months. The excessive growth of the thyroid in this species of small fish destroyed and replaced gill structures, thus impairing the function of this important tissue.

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EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. Section through the head of normal *Rasbora lateristriata* made at the level of the eyes. The small compartment containing thyroid tissue is indicated by the circle, *O. M*, floor of the mouth. x 15. Compare with the hyperplastic mass of thyroid seen in Fig. 5, Plate II.

Fig. 2. Four normal thyroid follicles, 1, 2, 3, 4, lying slightly dorsal to the aorta, A, near the origin of the branchial arteries, X and Y. x 125.

Fig. 3. Cluster of ten normal colloid-containing follicles dorsal to the aorta, A. x 200.

Fig. 4. Three normal thyroid follicles attached to a vein, V. A marks the aorta. x 500.

Plate II.

Fig. 5. Low power magnification of hyperplastic thyroid mass, T. x 13. The section is taken through the head at the level of the optic nerves. Compare with the normal thyroid area seen in Fig. 1, Plate I.

Fig. 6. Hyperplastic tissue with follicles of various sizes, with blood vessels at V and V′. x 175.

Fig. 7. Hyperplastic thyroid mass replacing gill tissue, G and G′. x 45.

Fig. 8. Thyroid follicles occupying gill structures. x 125.

Plate III.

Fig. 9. Hyperplastic thyroid invading muscle fibres, M. x 250.

Fig. 10. Hyperplastic thyroid infiltrating bony structures, B. x 125.

Fig. 11. Thyroid mass encroaching upon the aorta, A, near the region of the heart. x 58.

Fig. 12. Hyperplastic follicles with vacuoles in the colloid. Colloid material in follicles A and B appeared to be continuous through a break in the septum, S. x 250.

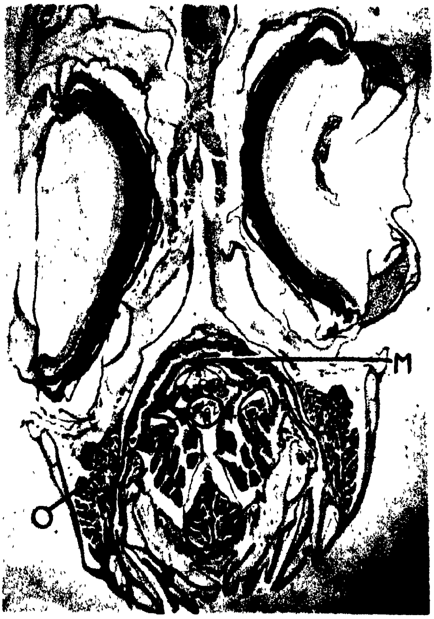

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

THE HISTOLOGICAL STRUCTURE OF THE NORMAL AND THE HYPERPLASTIC THYROID IN RASBORA LATERISTRIATA (BLEEKER).

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

THE HISTOLOGICAL STRUCTURE OF THE NORMAL AND THE HYPERPLASTIC THYROID IN RASBORA LATERISTRIATA (BLEEKER).

FIG. 9.

FIG. 10.

FIG. 11.

FIG. 12.

THE HISTOLOGICAL STRUCTURE OF THE NORMAL AND THE HYPERPLASTIC THYROID IN RASBORA LATERISTRIATA (BLEEKER).

22.

Lymphocystis in the Hogfish, *Lachnolaimus maximus.*

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New York Aquarium

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Department of Anatomy
Yale School of Medicine

(Text-figure 1).

One of several hogfish (*Lachnolaimus maximus*) received at the New York Aquarium in July, 1937, developed soon after arrival a number of small cutaneous tumors. With the use of a magnifying lens these tumors suggested lymphocystis disease, because they consisted of groups of small grayish-white colored nodules. These were distributed along the sides of the body, and on the dorsal, pectoral and tail fins.

The microscopic study of an excised piece from the border of a fin showed, both in total preparations and in the paraffin sections, that these lesions were clearly lymphocystis disease.

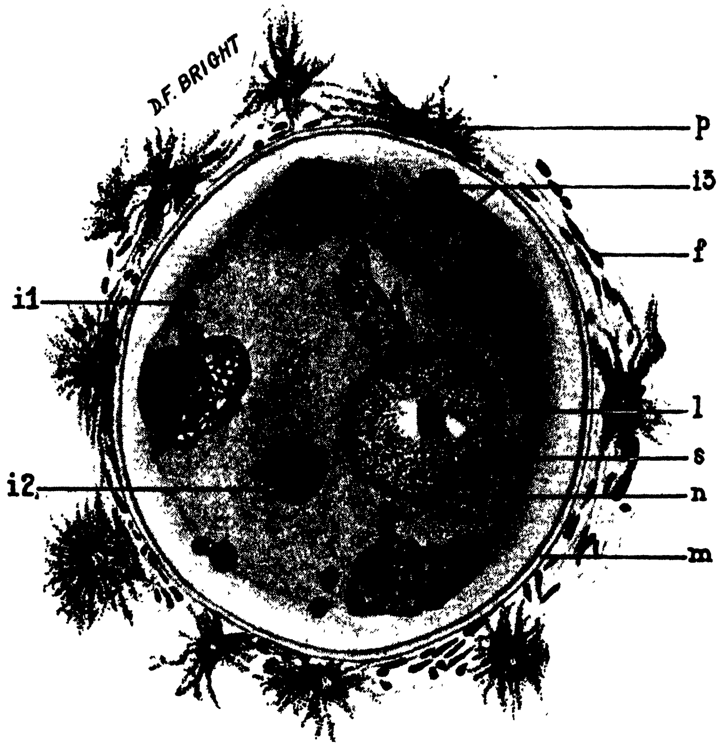
It is in the connective tissue of the fin host that the characteristic large lymphocystis cells were seen. These cells are similar to those noted by Weissenberg (1914, 1920, 1922) in two European species of fishes, the flounder (*Pleuronectes flesus*) and the ruffe (*Acerina cernua*), and more recently in America by Smith and Nigrelli (1937) in the angelfish (*Angelichthys isabelita*).

The lymphocystis cells have several conspicuous points of distinction. The cells, possessing only one nucleus, reach gigantic size; they are surrounded by a thick hyaline cell membrane; and finally, the cytoplasm contains very striking inclusion bodies which consist of a delicate network staining like the basophilic chromatin of the nucleus.

Text-figure 1 shows these characteristics in a relatively young lymphocystis cell, sketched from a total preparation stained with Delafield's hematoxylin. This oval-shaped cell measured 120 x 100 microns. It is surrounded by small connective tissue cells (f) and pigment cells (p). The enlarged nucleus (n) contains fine chromatin granules, one large nucleolus (l) and several smaller nucleoli (s). The cytoplasm, surrounded by the thick membrane, contains thirteen inclusion bodies of various sizes and form. These were sketched from different optical levels in relation to the nucleus. The dark bodies (i 2) lie in a plane above the nucleus, the

light gray (i 1) below the nucleus. Cell inclusions showing reticulated formation were chiefly demonstrable at about the level of the nucleus (i 3).

Because of the fact that there are numerous inclusion bodies, the lymphocystis cells in the hogfish more closely resemble those of the flounder. However, the reticulated bodies of the hogfish differ from those of the flounder lymphocystis cells of similar size in that they are of a more compact form. In the lymphocystis cells of *Acerina*, on the other hand, only one network of inclusion bodies surrounds the nucleus.



Text-figure 1.

Total preparation of lymphocystis nodule of hogfish, *Lachnolaimus maximus*. Stained with Delafield's hematoxylin. x 600. See text for explanation.

The smallest lymphocystis cells found in the tumors of the hogfish have a diameter of 120 microns, while the largest reach a size of 530 microns. The increase in size of the lymphocystis cells is usually accompanied by an increase in the number of inclusion bodies.

As to the interpretation of lymphocystis cells, Weissenberg (1914) has shown that they are not protozoa, but hypertrophied connective tissue cells of the host, probably stimulated to gigantic growth by the action of an intra-cellular virus.

It is interesting to point out here that the two species of fishes (*Angelichthys isabelita* and *Lachnolaimus maximus*) in which this disease has been recently found were collected at Key West, Florida.

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23.

Position of Wires in the Display of the Twelve-wired Bird of Paradise.

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(Text-figures 1-3).

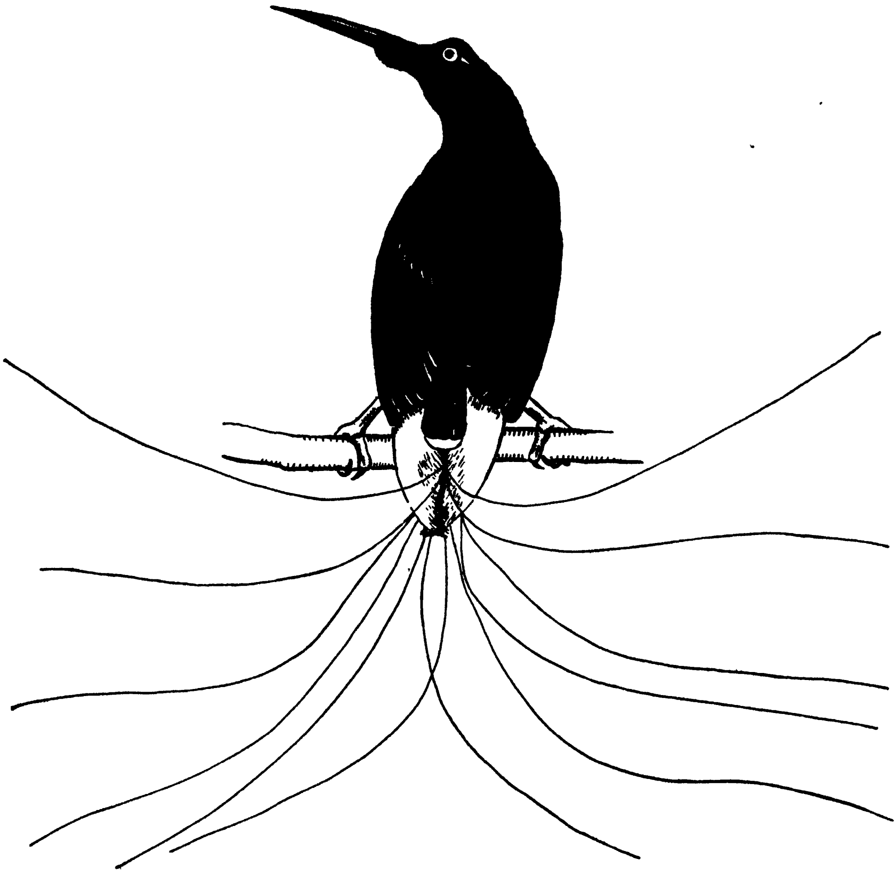
In a recent description[1] of the display of the Twelve-wired Bird of Paradise [*Seleucides melanoleucus melanoleucus* (Daudin)], I made no mention of the position of the wires. This was because the wires of the bird under observation had become so worn and broken that they could not function normally. Since the time when the original notes were made (March, 1937), the bird has been through a complete molt and the wires are now perfect. It might be noted that this is a most unusual condition, since in most captive birds of this species, these appendages are broken off almost as soon as they develop.

The wires, which rise from the inner sides of the flank plumes, and appear to be specialized feathers of this group, emerge between the tips of the plumes, immediately beyond the end of the tail. Just after emergence, each curves sharply, six to the right and six to the left. The two inner wires, which are shorter and more delicate than the others, show less tendency to curve. When the bird is perching normally, the wires extend outward and slightly downward, apparently without strict regard to order.

In display, with the feathers of the abdomen tightly compressed and the flank plumes slightly expanded in the perpendicular plane, there appears to be muscular pull or tension, which causes the wires to rotate slightly. This rotation has the effect of bringing the wires into set alignment, the outer ones extending to right and left in the horizontal plane, at about the level of the bird's extended body, the curve causing a distinct forward tendency. This plan is carried out in the inner pairs, each extending outward, downward and forward, with the outward tendency decreasing in each pair as the center is approached. In the delicate central pair, the direction is almost entirely downward and forward. This leaves the twelve wires, approximately evenly spaced, extending forward, around and beneath the bird's body, none rising higher than its level.

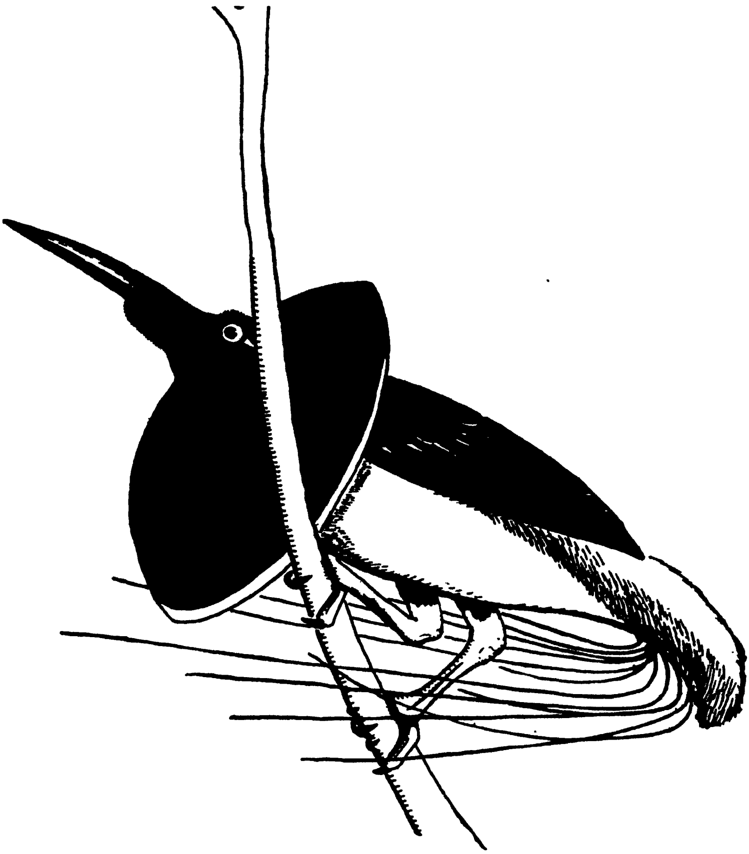
The three text-figures on the following pages represent the positions of the wires when the bird is at rest, and when displaying. The figures were drawn from life by Mr. Joel Stolper.

[1] *Zoologica*, Vol. XXII, Part 2, pp. 193-195, 1937.



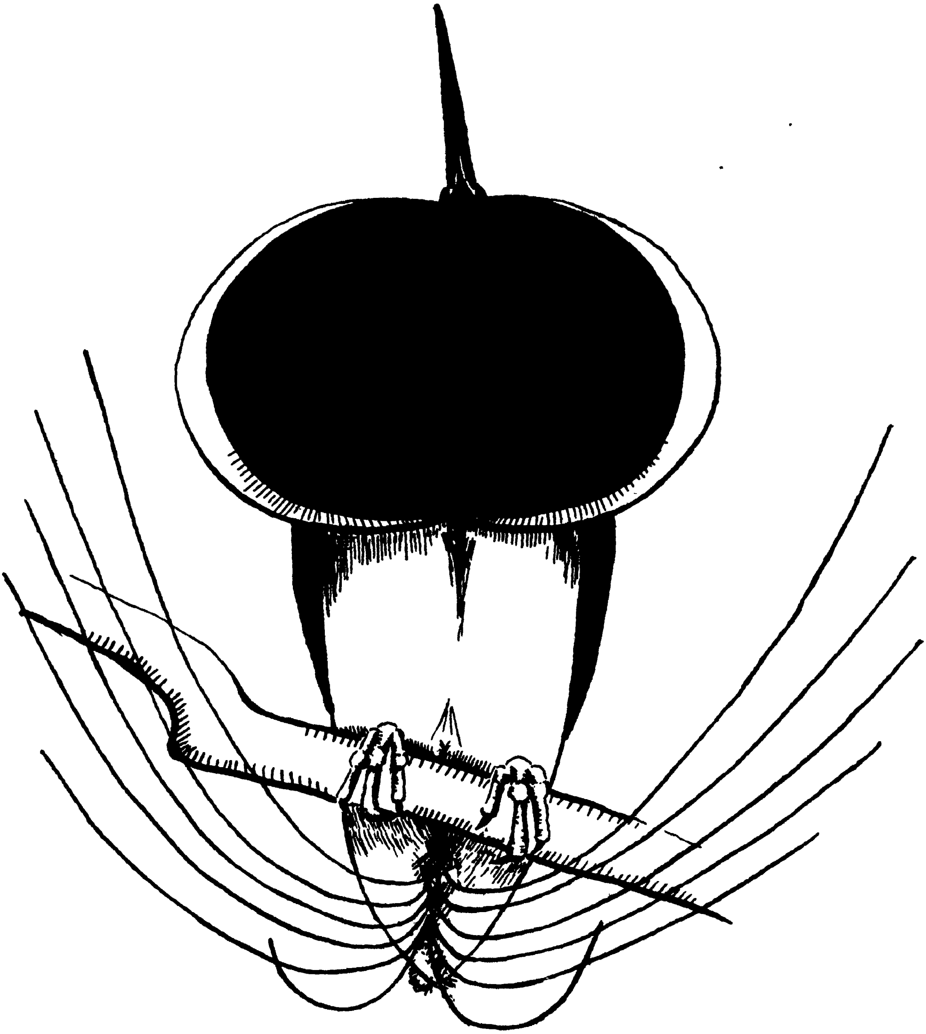
Text-figure 1.

Position of the wires of the Twelve-wired Bird of Paradise, *Seleucides melanoleucus melanoleucus*, when the bird is at rest.



Text-figure 2.

Position of the wires of the Twelve-wired Bird of Paradise, *Seleucides melanoleucus melanoleucus*, in display. Side view.



Text-figure 3.

Position of the wires of the Twelve-wired Bird of Paradise, *Seleucides melanoleucus melanoleucus*, in display. Viewed from the front and below.

24.

Display of the Magnificent Rifle Bird.

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Curator of Educational Activities
New York Zoological Park

(Text-figure 1).

Although in captivity for over a year, our Magnificent Rifle Bird (*Craspedophora magnifica intercedens*) has not been observed in display until a month previous to this writing (October 25, 1937). The authors have seen the display performances of fifteen species of the *Paradisaeidae* and agree that this species, through its use of a markedly different method of execution, achieves an astounding, unexpected result, the most magnificent display so far observed for the entire group. Without any particular preparation the full display is entered into almost instantly, and whereas the long-plumed birds of paradise usually present an aesthetic, gentle waving of these pleasingly-colored plumes, here we have something entirely different, a decidedly virile display.

The display of the rifle bird has been adequately described by Selous.[1] After viewing the display, as given dozens of times, it is evident that a certain amount of variation can enter without materially changing the character of the performance. It is, therefore, deemed advisable to record the display as observed at the New York Zoological Park, calling attention to apparent discrepancies in or deviations from Selous' account.

After the first-observed display of our Rifle Bird, hours were spent awaiting subsequent performances. A week or more went by and we were unable to observe satisfactorily a complete display. Finally, a mounted female was borrowed from The American Museum of Natural History and placed just outside of the cage occupied by our male bird. The response was immediate and we (or, more strictly speaking, the stuffed female), were presented with a half-dozen displays in forty minutes.

There are but few preliminaries at the most, for while the bird occasionally precedes a display with characteristic vertical extensions of the head and neck, or a feigned indifference, as evidenced by active preenings and pecking of the feet, just as frequently a full display is achieved without any preliminary actions whatsoever. Whatever the procedure, the observer is always taken by surprise.

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[1] Selous, Edmund C. Realities of Bird Life, 1927, p. 284-285.

There are two forms of the display, a long one and a short one. The short display was noted several times previous to the introduction of the stuffed female. Afterward, the long display was in vogue.

The Short Form of the Display.

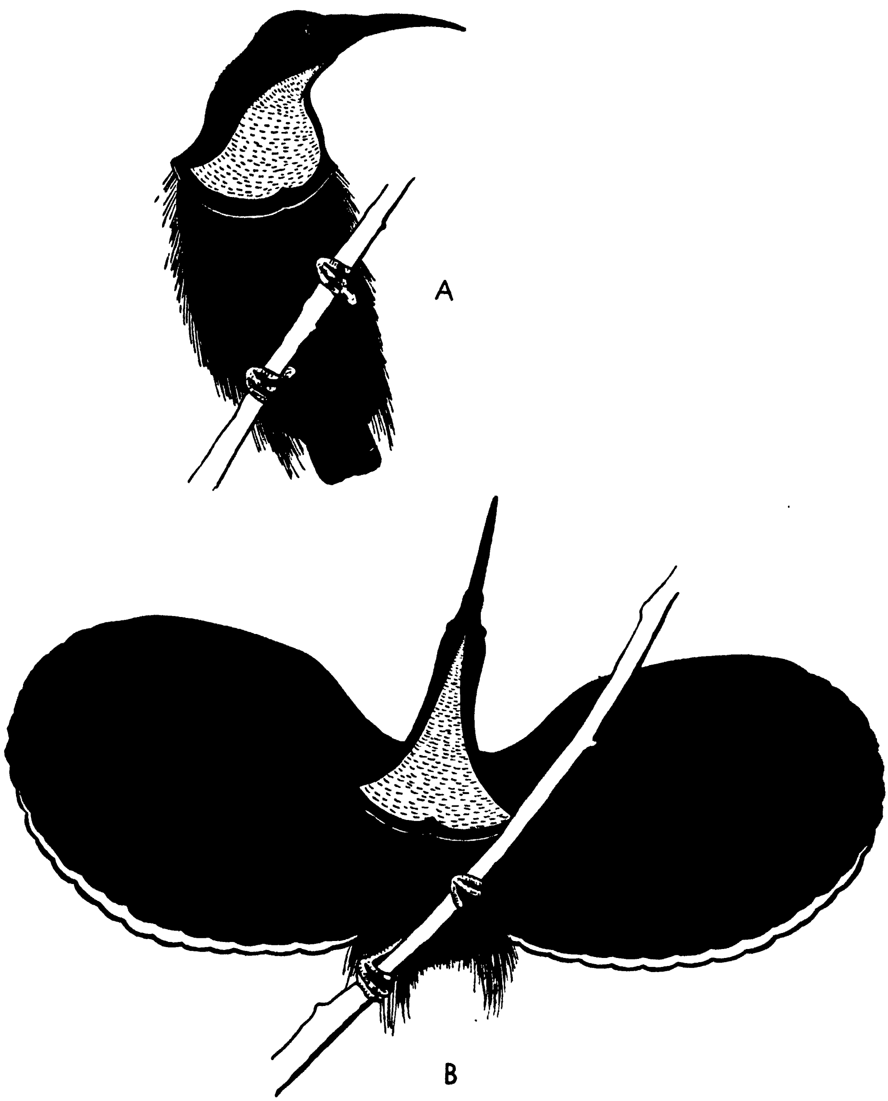
The bird enters into either form of the display while sitting upright upon a slightly ascending branch. Frequently the display is preceded by a few abrupt, jerky, vertical movements of the head and neck. With this slight warning the wings are then thrown slightly forward and opened wide, to their fullest extent. Simultaneously, the neck is extended and the head moved to one side and brought to rest just behind the bend of the outstretched wing. The head is then moved from side to side, first in a period of about two seconds but immediately and regularly increased in speed until brought to an abrupt stop in the middle after about a dozen movements. This is a remarkably rhythmic performance and the last few movements are executed with such rapidity that it is practically impossible to determine their extent. Apparently they become shorter as the speed is increased. As the head movements cease the wings are folded and the display ended.

The Long Form of the Display.

At the start of the display the wings are usually opened so abruptly as to produce a rustling "plop." As the head is being moved from one side to the other the bird rises on his perch and slightly elevates (thereby relaxing) the extended wings. Simultaneously, as the head reaches the opposite side, the body is lowered on the perch and the wings are snapped back to their fully-extended position. This again produces a sharp, rustling sound which is, of course, repeated with every similar movement of the wings, throughout the performance. All these movements are repeated in unison, again and again. The wings-extended-head-to-the-side position for the first few movements is held rigidly for about three seconds. The time of movement then decreases to about three-quarters of a second and is maintained to the end of the display. During the longest and most regularly-executed of the displays observed the head was moved from side to side thirty-five times, punctuated, in perfect rhythm, by the rustling snap of the extended wings. No two displays are exactly alike, for they are varied by changing the regular, rhythmic beat of these coordinated movements. Action may be slowed down for a few seconds, then speeded up to the original beat. It has also been noted that at times, as the bird rises and falls on his perch, he may move up or down the perch but this appears to be due rather to incidental relaxing of the grip than to a definite dance motive.

Tail and plumes seem to play no important part in the performance. During the display the tail is held up in the rear in a fairly horizontal position. While it may be spread a trifle and moved slightly from side to side, such movements apparently serve only to assist the bird in maintaining his balance. The plumes extend around and below the body and serve principally to obscure its junction with the extended wings.

The foregoing merely describes the action of the display and gives but little indication of the remarkable effect secured. The observer is completely taken by surprise when, directly in front of him, the wings of the Rifle Bird are suddenly extended to form a dark concavity, the black inner surface of primaries and secondaries meeting perfectly, with no visible break, to their very tips. Then, too, because of the shortened outer primaries, the shape of the extended wings is unusual, almost bat-like but more symmetrical and graceful. In contrast to this velvety background-drop the scintillating green gorget now moves rapidly from side to side. The observer's



Text-figure 1.
Magnificent Rifle Bird (*Craspedophora magnifica intercedens*). **A.** Normal pose. **B.** Attitude at end of short form of display, just before wings are closed. Drawings by Joel Stolper.

eye is riveted to this oscillating dart of glowing green, so much so that he can see little else, and the display must be watched over and over again before he is able to note the other actions involved.

The effectiveness of the display seems to be dependent upon the quality and amount of light. The colors of the gorget are a more brilliant green on a dull, cloudy day and are set off to better advantage against the velvety black of wings and body. On a bright, sunshiny day the gorget does not appear to be green at all, but blue, and on such days the display is less striking. A small area on the inner tips of the flight feathers has a peculiar

glazed appearance and under certain light conditions reflects a light blue-green color. During the display a band of this color is thus shown along the lower edge of the deep black of the extended wings. This color area is indicated in the accompanying drawing.

Voice seems to pay no part in the display and, unlike Selous, we have never heard a vocal sound during dozens of closely-observed displays. We have never noted the mouth to be held open, and in this species the brightly colored lining of the buccal cavity would seem to possess no significance in connection with courtship display.

Between display periods our Rifle Bird frequently utters his loud call notes and likewise a pleasing, low-pitched version of the same, almost conversational in tone. While it has been stated that the call notes are never uttered more than a few times in succession, our bird has called a dozen times without a break.

25.

The Templeton Crocker Expedition. XII. Sergestidae (Crustacea Decapoda) from the Lower Californian Region, with Descriptions of Two New Species and Some Remarks on the Organs of Pesta in *Sergestes*.[1]

MARTIN D. BURKENROAD
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(Text-figures 1-12).

[Note: This is the twelfth of a series of papers dealing with the specimens collected on the Twenty-fourth or Templeton Crocker Expedition of the Department of Tropical Research of the New York Zoological Society; William Beebe, Director. For data on dredges, localities, dates, etc., concerning the capture of specimens treated in this paper, refer to the present volume of *Zoologica*, No. 2, pp. 33 to 46.]

CONTENTS.

INTRODUCTION.

Of the six sergestids included in the present collection, two appear to be undescribed species; while two others, named forms which seem to be limited to the American Pacific, have never been completely diagnosed. I am deeply indebted to Dr. Beebe for the privilege of examining this material.

[1] Contribution No. 545, Department of Tropical Research, New York Zoological Society. Figures from camera lucida drawings by the author.

A list of sergestids recorded from the American Pacific but not included in the present collection is presented below:

1. *Sergestes inous* Faxon, 1893 and 1895; Hansen, 1919 (cf. Hansen, 1903, p. 69; and Illig, 1927, pp. 292-297). *S. profundus* Bate, 1888, p. 429, part (cf. Hansen, 1903, p. 69)?
2. *Sergestes edwardsii* Kroyer; Faxon, 1895, part (cf. p. 321 below. *S. oculatus* Kr., Faxon, 1895. *S. orientalis* Hansen, Cecchini, 1928?).
3. *Sergestes longispinus* Bate (the mastigopus of *S. cornutus* Kr. according to Hansen, 1922), Faxon, 1895.
4. *Sergestes longicollus* Bate, 1888, p. 422, part; Hansen, 1922, p. 92.
5. *Acetes binghami* Burkenroad, 1934.
6. *Lucifer orientalis* Hansen, Cecchini, 1928; Boone, 1930.

Sergestes H. M. Edwards.

In previous considerations of the genus, one set of structures of very considerable systematic importance has been neglected, namely the internal cephalothoracic organs briefly noted by Pesta, 1918 (quoted by Hansen, 1922, p. 21), in *S. corniculum*, *S. arcticus* and *S. vigilax*. As Pesta observes, the form of these structures [which may be termed the *organs of Pesta*] suggests for them a luminescent function; but whether this is actually the case I am unable to say inasmuch as varied manipulations of several living specimens of different species of *Sergestes* which possess the organs were not effective in inducing the production of light. If the organs are indeed luminescent, they seem to be the only ones known among crustacea which have been developed from endodermal tissue (cf. Dahlgren, 1916, p. 821: "They [rods of the photophores of euphausiids] thus stand, as one factor, in the evidence that these light cells . . . have, in common with most other light-cells, an ectodermal origin.")

The organs of Pesta seem from the study of dissections to be modified areas of the surface of the gastric gland (which is in almost all of the species of *Sergestes* a structure of relatively enormous size); these modified areas total altogether perhaps a tenth or twentieth of the bulk of the gland. The modified portions of the gland consist of groups of about 8 to 30 or more ventrally directed tubules, the terminal portions of which are constructed of a dense layer of columnar tissue bright Antwerp blue in color in the living animal. The dorsal, or more proximal, portions of the modified tubules are white and are more loosely constructed than the terminal parts, and merge (in the case of groups of modified tubules not pinched off from the body of the gastric gland) with tubules of more ordinary type, although tissue connected with the modified tubules seems to differ from that of the mass of the gastric gland by an increased density of granulation and in other ways. That part of the tunic of the gastric gland which covers the dorsal parts of the areas of modified tubules bears a dense layer of carmine chromatophores, and similar pigment surrounds the necks of the distal parts of the modified tubules themselves and lies between these tubules and the ordinary ones, so that each of the modified areas has in life the appearance of a fringe, cluster or spherule of blue (opaque yellow or white in preserved material) ellipsoidal bodies covered dorsally with a carmine cap and lying more or less near to or embedded in the translucent gastric gland.

The modified areas always include a pair at the anterior end of the gastric gland and almost completely separated from it, which seem the most highly developed of the organs. In addition to these there are always some modified tubules at the posterior end of the gland, variously organized as an undivided lateral and posterior fringe, a single posterior organ, a pair of posterolateral organs with or without an additional posteromedian area,

or even two posterolateral pairs plus an unpaired posteromedian one. The posterior organs also vary considerably from species to species in degree of consolidation. Finally, there may be an unpaired anteromedian area, and also a small pair of organs lying in the middle of the sides of the gastric gland. The modified areas or organs of Pesta of the anterior pair lie just above the dorsal wall of the branchial chamber, behind the dorsal end of the base of the mandible; and their ventrally directed uncapped surfaces are exposed to the exterior through the doubled but transparent integument overlying them. The organs at the posterior end of the gland are in part plainly exposed through the gap in the lateral musculature just above the branchial area of the thirteenth somite. The posteromedian, anteromedian, paired midlateral and anterior pair of posterolateral (when the posterolateral areas are subdivided) organs are however, when present, more or less invisible from the exterior (and were indeed overlooked by Pesta, who mentions only two pairs in *S. corniculum* which actually possesses ten distinct organs). The anteromedian area in particular, dorsally and posteriorly hooded by its pigment layer, faces through a layer of muscle into the densely pigmented posterior wall of the foregut.

Organs of Pesta appear to be present in all members of the genus other than the *S. mollis, S. tenuiremus, S. robustus* and *S. challengeri* superspecies of Hansen's "Group I." In available specimens of these latter four groups (which include altogether about half, or sixteen species of the genus), no portion of the gastric gland seems to be conspicuously modified. In compensation, however, numerous small complex photophores occur in the dermal layer of *S. challengeri* and related forms; and in *S. robustus* and its close relatives there are numerous small simple subcuticular bodies (Illig, 1914, p. 354[2]; Hansen, 1919, p. 10; Sund, 1920, pp. 11, 15, 18; Hansen, 1922, p. 21; and below, p. 324) the appearance of which suggests a luminous function particularly in fresh-caught material where (*S. crassus* Sund taken in the Straits of Florida during a recent expedition of the Bingham Oceanographic Foundation) these bodies appear as lenticular transparent structures invested on their inner sides by a layer of vermilion pigment. Surficial and presumably ectodermal or mesodermal photophores of these types, which have no structural relation at all to the endodermal organs of Pesta, seem to be absent in all of the species in which the latter occur.

As regards the systematic significance of the organs of Pesta, aside from their value as specific or superspecific diagnostics (which is in practice reduced by the fact that their elucidation requires a certain amount of damage to the specimen) their greatest interest lies in the possibility that their presence or absence marks the genus off into two natural groups the members of which seem in many other features as well to display more resemblance to one another than they do to the members of the other group. Without detailing the evidence or venturing at this time to modify Hansen's system, it may be stated that the distribution of certain characters among the species equipped with the organs of Pesta suggests that enlargement of the third maxillipedes may possibly have occurred independently in two different stocks, so that the form of these appendages may perhaps not be so significant of degree of relationship as Hansen's method of subdivision of the genus implies.

A more extensive consideration of the matters introduced above may be deferred until an exhaustive review of *Sergestes* has been completed. As will be shown on a subsequent page, the characters heretofore relied upon for separation of *Sergestes* from *Petalidium* are not diagnostic, and the major as well as the minor features of relationship within the subfamily therefore seem to be in need of further study.

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[2] Illig finds these bodies present in *S. robustus* Smith and in "*S. kroyeri* Bate." It is believed by Hansen, 1922, p. 91, that by *S. kroyeri* Illig refers to the *S. tenuiremus* Kr. of Hansen; however, no such rows of glandular patches seem to occur on the appendages of *S. tenuiremus*, and it would therefore appear that Illig refers, in part at least, to some other species.

Sergestes pestafer, sp. nov.

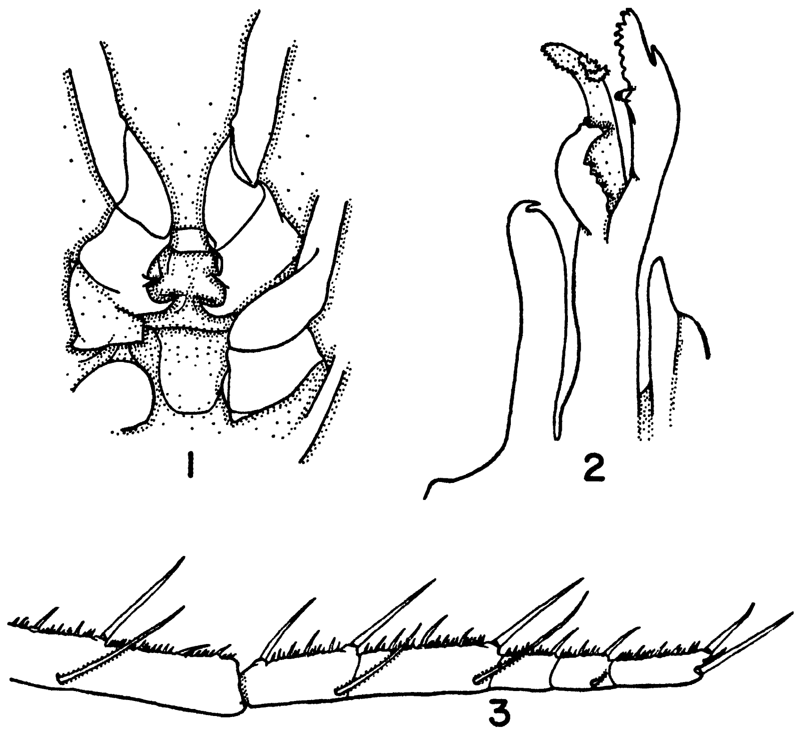
Text-figures 1-3.

Type: Holotype, Cat. No. 361,031, Department of Tropical Research, New York Zoological Society. Taken at Station 165 T-3; 20° 36′ N. Lat., 115° 07′ W. Long., 145 miles N. of Clarion Island, eastern Pacific; meter net at 500 fathoms; May 17, 1936. Paratype: Cat. No. 361,030, Station 130 T-1, 25° 17′ N. Lat., 113° 25′ W. Long., 68 m. WNW. of Cape San Lazaro, Lower California; meter net at 400 fathoms; March 28, 1936.

Range: Eastern Pacific off Lower California, the Cocos, and the Galápagos Islands. Midwater at levels of 400-600 fathoms or less, in depths of 500-2,000 fathoms.

Material: Two specimens were taken in the Pacific off Lower California in depths of 400-600 fathoms, as follows: *Station* 130: T-1 (1 ♂); *Station* 165: T-3 (1 ♀). Cat. Nos. 361,030, 361,031. Three males and three females from the collection of the Department of Tropical Research taken at *Arcturus* stations 74 and 86 have also been examined.

Dimensions and Sexual Condition: Female, adult, with ripening ovaries, of carapace 9.5 mm., total length 28 mm. Male, adult, of carapace 7 mm., total length 22 mm.



Text-figures 1-3.

Sergestes pestafer, sp. nov. **1.** Thelycum; adult ♀, TYPE, D. T. R. 361,030, x 18. **2.** Petasma (left endopod, anterior view of distal part); adult ♂ TYPE, D. T. R. 361,031, x 37. **3.** Third maxillipede (of the left side, median view of dactyl and distal part of propodus); as in 1, x 18.

Diagnosis: Organs of Pesta present, consisting of only five areas (a highly developed anterior pair almost completely isolated from the gastric gland; a well-developed ovoid posterior pair distinctly set off from the gland; and a small and less well differentiated posteromedian area). Supraorbital and hepatic spines present; telson with only a single pair of dorsolateral spinules, and with a terminal point. Distal article of antennular peduncle relatively long and slender in both sexes, although shorter than the basal segment. Third maxillipedes very long and basally much swollen; propodus much longer than dactyl and these two distal segments with many spines on one margin, a few only on the other; dactyl divided into five subsegments of which the inner margin of the ante-penultimate bears in males eight, in females eleven or twelve spines of all sizes. Ischium of the first and second legs with a spine on its outer margin; carpus of the first legs much shorter than the propodus; chelae of the second and third legs with fixed finger conspicuously shorter than the mobile one and palm with a longitudinal series of long setae; the two distal segments of the fifth legs setose on both margins. Ciliated portion of the external margin of the exopod of the uropods about one and one-half times as long as the unciliated part, and not separated from it by a tooth or spinule. Neck of the capitulum of the petasma long; processus uncinatus not reduced and with distal hook; processus ventralis not reduced and armed, in addition to a row of simple spinules, with one to three large stellate spines; lobus armatus curved medially and not extending to more than three-fifths the length of processus ventralis, its median margin armed with several hooked spinules; lobus terminalis bearing a small slender lobus internus closely applied to its median edge, and with the distal third of its lateral edge armed with a row of hooked spinules. The posteroproximal corner of the precoxa of the third legs of the females bears a conspicuous laterally directed spur; the coxa is armed on its posteromedian edge with two teeth, the distal of which is, although much smaller than the proximal, decidedly produced, so that the margin of the coxa proximal to it appears concave.

Remarks: *Sergestes pestafer* is very closely related to the *S. sargassi* Ortmann of Hansen, 1922, p. 148, and is distinguished from it only in a few minute but apparently rather constantly different details. In adults of *S. sargassi*, according to figures by Hansen and by Sund, 1920, p. 26, (sub *S. henseni* Ortmann) which are in agreement with North Atlantic specimens in the Bingham Oceanographic Collection, the inner margin of the antepenultimate subjoint of the dactyl of the third maxillipedes bears only four or five spines. Lobus armatus of the petasma reaches to two-thirds or more the length of processus ventralis; the latter bears five or more large stellate spinules; lobus terminalis is armed only with a single spinule at the tip, and lobus internus is relatively larger than in *S. pestafer* and divergent from lobus terminalis. The distal of the two pairs of projections arming the posteromedian edge of the coxa of the third legs of the female usually appears more like a sharp angle than a produced tooth, and the margin of the coxa proximal to it is more or less straight so that the portion of the margin lying between the tips of the two teeth often appears > -shaped rather than ⊃ -shaped as in *S. pestafer;* the degree of development of the distal tooth in *S. sargassi* seems however to be somewhat variable. It may be noted that the supraorbital spines seem sometimes to be absent in *S. sargassi.*

The precise synonymy and the specific relationships of the *S. sargassi* group of species are in a state of some confusion, and it is particularly difficult to interpret the descriptions of Illig, 1927, of *S. pectinatus* Sund, *S. henseni* Ortmann, and *S. nudus* Illig (a form which as described for the second time, from adults, would seem to combine characters of the *S. edwardsii* with those of the *S. sargassi* superspecies in a very peculiar fashion). However, *S. pestafer* appears to be quite distinct from any of the material figured by Illig under these names. It seems possible that

the mastigopus of 7.8 mm. from north of the Galápagos, recorded as *Sergestes sargassi* Ortmann by Cecchini, 1928, p. 38, refers to *S. pestafer.*

No attention seems heretofore to have been bestowed upon the great resemblance in critical features of the *S. sargassi* to the *S. corniculum* superspecies, which is particularly marked as regards the peculiar form of the second and third chelae, as well as in the unique combination of various other characters. These two superspecies seem, indeed, to be distinguished from one another only as regards the form of the third maxillipedes, among characters of more than specific significance. In the present incomplete state of the resurvey of the genus, it appears possible that the *S. sargassi* superspecies and the *S. vigilax, S. edwardsi* superspecies may respectively be linked by way of the *S. corniculum* and the *S. atlanticus* to the *S. arcticus* superspecies, which last seems the nearest of all these forms to the group of superspecies which lacks the organs of Pesta.

Sergestes halia Faxon.

Text-figures 4, 5.

Sergestes halia, Faxon, 1893, p. 217.

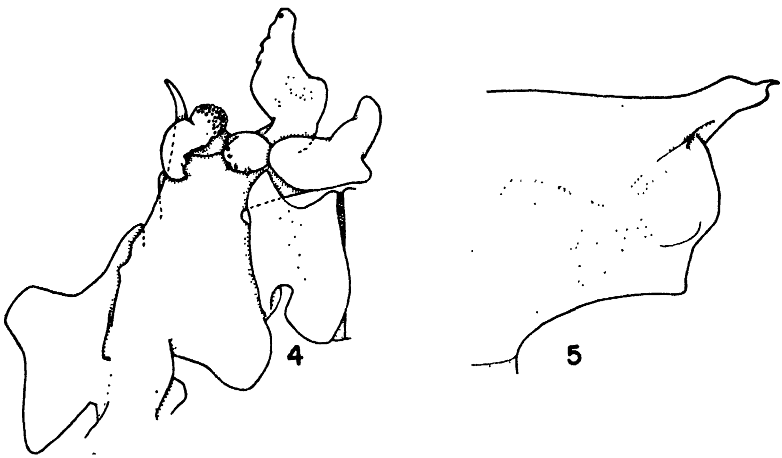
Sergestes edwardsi Kr., part, Faxon, 1895, p. 212.

Sergestes halia, Hansen, 1896, pp. 950, 960, 962.

Range: Gulf of Panama; off southeastern and southwestern Lower California. Midwater at levels above 300-500 fathoms.

Material: A total of 9 specimens (two being males) was taken off the southwest (Station 134) and the southeast (Stations 156, 158 and 159) coasts of Lower California, in 235 to 550 fathoms, as follows: Station 134: T-3 (1 ♂, 1 ♀); Station 156: D-2 (1 juvenile); Station 158: T-4 (2 ♀); Station 159: T-1 (2 ♀), T-2 (1 ♂), T-3 (1 ♀). Cat. Nos. 361,032, 361,033, 361,034, 361,035, 361,036, 361,037.

Dimensions and Sexual Condition: Females ranging in carapace length from 9.5 mm. to 15 mm., total length 25.5 mm. to 39 mm. Ripening ovaries are present in all of carapace 11 mm. or more. Males, adult, of carapace length 10 mm., total 28 mm. The juvenile specimen has a carapace length of 5.5 mm.



Text-figures 4 & 5.

Sergestes halia Faxon. **4.** Petasma (left endopod, anterior view); adult ♂, D. T. R. 361,032, x 26. **5.** Carapace (lateral view of anterior part); as in 4, x 13.

Remarks: In 1895 Faxon concluded that his *S. halia*, described in 1893, represented "large and mature individuals of *S. edwardsi*," especially as Kroyer had recorded a variety of that species with rostrum larger than the typical. Faxon therefore identified his three specimens of *S. halia* with other smaller individuals taken by the *Albatross* which he referred to *S. edwardsi* Kr. In 1896, Hansen pointed out (p. 947) that Kroyer's "variety" of *S. edwardsi* is a species (*S. diapontius* Bate, to which, indeed, Illig, 1914, p. 365, suggests that Faxon's species may refer) related to *S. vigilax* and quite distinct from the type; and he proposed (p. 963) to revive *S. halia*, as a valid species closely related to *S. armatus* Kr. of the *S. vigilax* group.

The present material of *S. halia* seems to differ from *S. armatus* (according to Atlantic specimens of the latter in the Bingham Oceanographic Collection and to the figures by Hansen, 1922) most conspicuously as regards the form of the anteroinferior corner of the carapace, which is almost rectangular in *S. halia* instead of gently rounded as in *S. armatus* and related forms. The anterior part of the ventral margin of the carapace is naked, not setose as in *S. armatus*. The fairly conspicuous tubercle of the distomedian edge of the ocular peduncle of *S. armatus* is hardly indicated in *S. halia*. The third maxillipede, uropodal exopod, thelycum of the female, and various other features of *S. halia* seem to differ only very slightly from these structures in *S. armatus*. The petasma of *S. halia* presents a few minute but characteristic differences from *S. armatus;* thus, the distal part of lobus internus of the capitulum of the petasma extends much higher than does lobus connectens in large specimens of *S. halia*, and lobus terminalis is mitten-shaped instead of finger-like; both of these features are indicated in somewhat exaggerated form in Faxon's Plate LI, figure le (sub "*S. edwardsii*"). Of other petasmal differences, the armature of lobus terminalis is more extensive in *S. halia* and is placed upon the latero- instead of mediodistal edge; and lobus connectens bears only six or eight spinules upon its anterior face which are more or less concentrated toward the lateral side, instead of a dozen distributed over the entire anterior face.

The juvenile specimen of the present collection, perhaps better termed a late mastigopus, has eyes of a pale chocolate color, and a rostrum stretched out into a long slender tip, nearly one-third as long as the carapace; otherwise it nearly resembles the adults.

Hansen, 1922, p. 188, remarks that "Les données de Faxon (1895) sur l'occurence de *S. edwardsi* dans le Pacifique tropical oriental doivent être tenues pour extrêmement douteuses, surtout parce que le grand spécimen figuré par lui . . . doit appartenir à une espèce très différente mais encore inconnue." However, although the large specimens are indeed of another species, it seems probable that the smaller of the specimens recorded by Faxon as *S. edwardsii* are actually referable to this name inasmuch as, in sorting the *Arcturus* Sergestidae, a quantity of material which seems to pertain to *S. edwardsi* has been encountered.

Sergestes similis Hansen.

Sergestes similis, Hansen, 1903, p. 60; Illig, 1927, p. 310.

Sergestes atlanticus H. M. E., Bate, 1888, p. 320, part.

Sergestes atlanticus Rathbun, 1904, p. 145, part.

Sergestes similis, Schmitt, 1921, p. 19.

? *Sergestes articus*, Cecchini, 1928, p. 33.

? *S. nasidentatus*, Bate, 1888, p. 398; Hansen, 1896, p. 957; 1903, p. 62.

Range: Pacific off western North America, including Gulf of California. South Atlantic off southwest Africa; Pacific off Japan. Midwater above 145-500 fathoms.

Material: A single specimen was taken in the Gulf of California off Tiburon Island, in 500 fathoms, as follows: *Station* 148: T-4 (1 ♀). Cat. No. 361,038.

Dimensions and Sexual Condition: The specimen is a juvenile female of carapace 6.1 mm., total length about 21.6 mm.

Remarks: As regards shape of rostrum and relative size of branchiae, the present specimen agrees very well with the Japanese type as described by Hansen, 1903. The anterodorsal margin of the carapace, below the post-orbital ridge, is however nearly vertical and slightly concave, much as in *S. arcticus* Kr.; a difference from the type perhaps due to the smaller size of the present individual. The genital structures are quite undeveloped.

According to Schmitt, 1921, the "*Sergestes atlanticus*" 40 to 52 mm. in length from Pacific America recorded by Rathbun, 1904, are referable to *S. similis*. Rathbun (p. 145) has synonymized with her "*S. atlanticus*" the *S. pacificus* described by Stimpson, 1860, p. 45, from an individual "1.25 poll." in length taken in the western North Pacific. Hansen, 1922, pp. 52-53, who has evidently overlooked Rathbun's record of the lengths of her specimens, tentatively accepts her determination and synonymy, remarking that "Stimpson . . . établit *S. pacificus* sur des spécimens . . . mesurant 1.25 inches, soit environ 33 mm.; les plus grands spécimens de *S. atlanticus* me paraissent être un peu plus petits, mais je ne puis trouver aucune différence réelle entre la très brève description de Stimpson et *S. atlanticus* . . . Les specimens nommés par M. Rathbun . . . appartiennent certainement à la forme décrite par Stimpson." However, it seems to me improbable that *S. pacificus* was identical with the specimens described by Rathbun, and very possible that it does not refer to *S. atlanticus* either. Stimpson's description seems to exclude adult forms of all of the known species of *Sergestes* except *S. atlanticus* H. M. E. and *S. cornutus* Kroyer, since the third maxillipede of *S. pacificus* is not indicated to be enlarged; the lateral margin of the uropodal exopod is stated to bear a small tooth beyond its middle; and the third segment of the antennular peduncle is stated to be much longer than the second. It seems unlikely that the "dente praeorbitali" of Stimpson's description ("Carapax minus elongatus, rostro brevissimo conico resimo, et spina vel dente praeorbitali armatus; spina hepatica quam in *S. Frisii* magis posterior") refers to anything but a post-terminal rostral tooth (compare his description of *S. macropthalmus*, "carapax spina hepatica et spina supra-orbitalis armatus . . . Rostrum brevissimum, resimium, apice antrorsum flexum;" and that of *Sergia remipes*, "carapax valde elongatus . . .; spine hepatica nulla. Rostrum minutum spiniforme, acutum, curvatum, dorso dente vel spina armatum."); this feature, then, would exclude *S. atlanticus*. The remaining species, *S. cornutus*, has been recorded by Hansen, 1922, p. 53, from a locality very near that where *S. pacificus* was taken. If Stimpson's unit of measurement, "poll.," is intended to mean *inch*, his specimen of *S. pacificus* would be much larger than any of *S. cornutus* (a species still smaller than *S. atlanticus*) heretofore recorded; it seems possible, however, that for inch Stimpson would have used the common equivalent *uncia*, a twelfth part; whereas *pollex* is an alternative form of *digitus*, the one-hundredth part of an "org." or fathom (a term also employed by Stimpson) and the sixteenth part of a foot. In this case, Stimpson's "poll." would be equivalent to 18.5 mm. instead of 25.4 mm., and the specimen of *S. pacificus* would have a length of about 23 mm. instead of 32 mm., a size not too far in excess of that which *S. cornutus* sometimes attains. It seems of interest to note that Faxon (1895, p. 214) records "*Sergestes longispinus* Bate," a name which according to Hansen is referable to the mastigopus of *S. cornutus*, from the eastern Pacific.

It is possible that *Sergestes longicaudatus* Stimpson, 1860, p. 46, a late mastigopus or juvenile "0.75 poll." in length (14 mm. or 19 mm., depending on whether by "poll." Stimpson means a twelfth or a sixteenth of a foot)

taken in the middle North Pacific, may refer to *S. similis*, but as its description might also apply to several other members of Hansen's "Group I" no decision can at present be reached.

It seems possible that the "*S. articus* Kroyer" recorded by Cecchini, 1928, p. 33, from off the coast of Chile may refer to the present species rather than to *S. arcticus*, but no description of the branchiae of these two juvenile males is offered. Cecchini's figure of the petasma of a specimen 25 mm. in length indicates the general form to be similar to that in *S. arcticus*. The genitalia of adults of *S. similis* from the eastern or western north Pacific have never been described.

Sergestes phorcus Faxon.

Text-figures 6, 7.

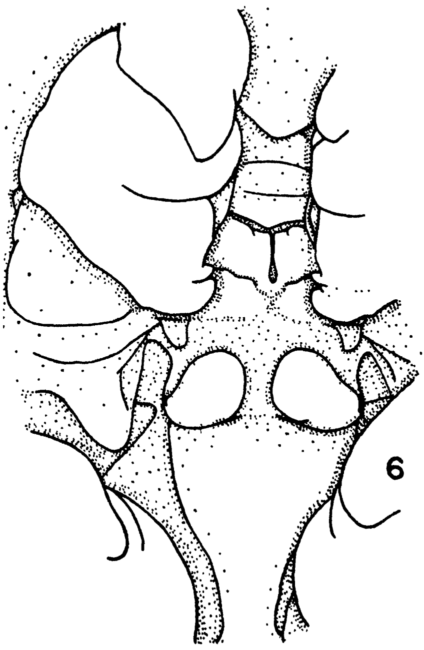
Sergestes phorcus, Faxon, 1893, p. 217.

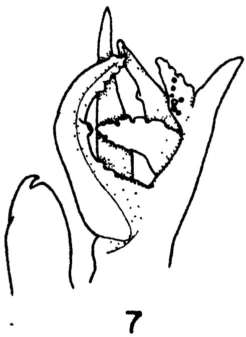
Sergestes bisulcatus W. M., Faxon, 1895, p. 210.

Sergestes phorcus, Hansen, 1919, p. 5, part; Sund, 1920, p. 16; Hansen, 1922, p. 97; Boone, 1930, p. 121.

Range: Eastern Pacific off Galápagos Islands and Lower California; Gulf of Panama; Gulf of California. Midwater at levels above 242-550 fathoms in depths of 242-2,000 fathoms.

Material: A total of 4 specimens was taken in the Pacific off Lower California (Stations 134 and 165) and in the Gulf of California (Stations 139 and 148) in 300 to 550 fathoms, as follows: Station 134: T-3 (1 ♂





Text-figures 6 & 7.

Sergestes phorcus Faxon. **6.** Thelycum; adult ♀, D. T. R. 361,040, x 15. **7.** Petasma (left endopod, anterior view of distal part); adult ♂, D. T. R. 361,041, x 15.

juvenile); Station 139: T-4 (1 ♂); Station 148: T-6 (1 ♂ juvenile); Station 165: T-3 (1 ♀). Cat. Nos. 361,039, 361,040, 361,041, 361,042.

Dimensions and Sexual Condition: Female, adult with ripening ovaries, carapace 25 mm., total length 74 mm. Male adult, total length 57 mm.; juveniles, total length 29 mm.

Remarks: *Sergestes phorcus* is very closely related to *S. grandis* Sund, from which it seems to differ principally as regards petasma and thelycum. Differences in petasma have been fully described by Hansen, 1922, p. 97. The thelycum differs from that of *S. grandis* as figured by Hansen, 1922, plate V, fig. 3n, in that there is a sharply-cut transverse ridge, interrupted in the midline, just in advance of the posterior margin of the base of the third legs; and in that the portion of the twelfth sternite lying behind the level of the third legs bears a pair of subtriangular elevations which are quite well defined. The posteromedian corner of the coxa of the third legs of the female of *S. phorcus* bears a pair of blunt projections instead of a single tooth as in *S. grandis*.

In the present large female opaque patches similar to those which occur in other species of the *S. robustus* group and which are believed to be luminous organs are perceptible in considerable number. There is a row of ten of these patches along the inner margin of the antennal scale; two or three on the distal part of the exopod of the uropod, one at the base of the ischium in all five legs, one or two at the distal end of the ischium of the second and third legs, a row of seven in the merus of the first leg, of ten in the same joint of the third leg, and one patch in the base of the merus of the fourth leg.[3] There appear also to be less readily distinguished patches of the same sort on other parts of the body, as on the ventral surface of the sixth pleonic somite, on the sides of the pleon, between the pleopods, and on the precoxae of the pereionic legs. The patches are less numerous and less well-defined in the smaller specimens, but appear to occur in all.

Petalidium Bate.

Petalidium, Bate, 1881, p. 194; Hansen, 1922, p. 189.

Petalidium has in the past been considered to differ from *Sergestes* mainly in the smaller number and lesser degree of ramification of its gills and in the bifurcation of the processus ventralis of its petasma. However, in a Pacific American species described below which must undoubtedly be considered congeneric with *Petalidium foliaceum* Bate and *P. obesum* (Kroyer), the number of gills is the same as in *Sergestes*. The gills of the ventral series (the anterior arthrobranchs, after Burkenroad, 1937, p. 510), although with fewer rami and lamellae in the new *Petalidium* than in the least developed species of *Sergestes*, are yet considerably more richly branched in the new species than in the two species of *Petalidium* which have been previously described. The petasma of the new species is, most unfortunately, unknown; but it may be observed that in view of the slight but distinct subdivision of processus ventralis in *Sergestes mollis* Smith, described by Hansen himself (1922, p. 78), it is doubtful whether this feature can be considered as a clear generic distinction.

Although it seems best for the present to retain the accepted generic grouping (thus, Gurney, 1924, p. 95, finds the larvae of the two genera to differ), a re-evaluation of the relationship of *Petalidium* to *Sergestes* is undoubtedly required. Characters by which *Petalidium* may be distinguished from the *Sergestes mollis* superspecies are detailed on p. 327 below.

[3] The occurrence of these patches on the legs of species of the *S. robustus* group, which has not been previously reported in print, was pointed out to me by Dr. F. A. Chace, Jr., of the Museum of Comparative Zoology.

Petalidium suspiriosum, sp. nov.

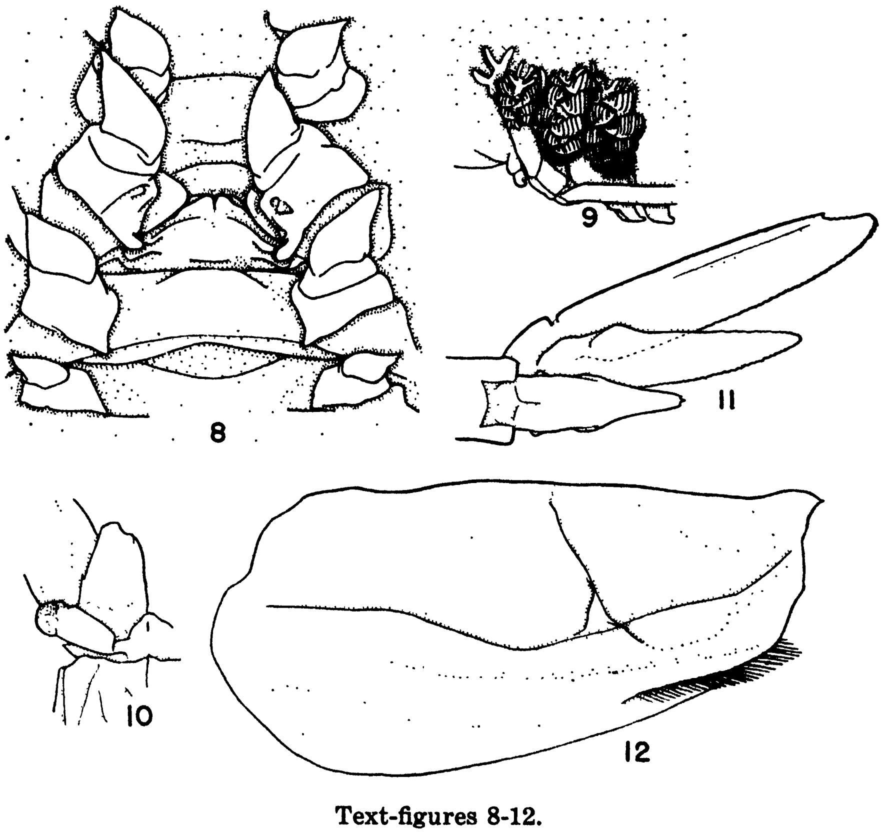
Text-figures 1-6.

Range: Definitely known only from the type locality in the eastern Pacific off Mexico, midwater at a level above 500 fathoms. Possibly off San Diego, California, depth 417 fathoms ("*Sergestes* sp. indet.," Rathbun, 1904, p. 146).

Material: A total of two specimens, both females, was taken 145 miles north of Clarion Island, Revillagigedo Islands, in 500 fathoms, as follows: Station 165: T-3 (2 ♀). Cat. No. 361,043.

Dimensions and Sexual Condition: Larger female apparently adult but with undeveloped ovaries, carapace 12 mm., total length 36.5 mm. Subadult female, carapace 8 mm., total length 26 mm.

Diagnosis: A podobranch and an arthrobranchial lamella are present on the eighth somite. An anterior arthrobranch, of up to thirteen rami placed alternately along the petiole, each of which may bear up to as many as twelve lamellae; and a lamella representing the posterior arthrobranch are present on somites IX, X, XI, and XII. A well developed anterior arthro-



Text-figures 8-12.

Petalidium suspiriosum, sp. nov. **8.** Thelycum; adult ♀, TYPE, D. T. R. 361,043, x 13. **9.** Branchiae (of somites XI-XIII); as in 8, x 6. **10.** Eye (of left side, dorsal view); as in 8, x 6. **11.** Telson and uropod (of left side, dorsal view); as in 8, x 6. **12.** Carapace (lateral view); as in 8, x 6.

branch consisting of nine rami bearing up to six lamellae each, and a small posterior arthrobranch of three rami of several lamellae each, are present on XIII.

The cervical sulcus is very distinct and is continued across the dorsum of the carapace although not here accompanied by the sharp carina marginal to it on the sides of the carapace. The cardiaco-branchial carina (and its anterior continuation, the antennal carina) is well developed. A minute hepatic spine is present. The postorbital carina is very weak and is unarmed. The rostrum is very short and fairly high with a pointed tip. It bears a rudimentary dorsal tooth in the smaller specimen. The telson narrows abruptly to a small terminal spine flanked by a pair of fixed lateral teeth. The integument is membraneous, smooth and shining, without reticulated pattern save that produced by subcuticular tissues in the antennal scales and uropods.

The cornea of the eyes is about one and one-half times wider than long; there is a well-developed tubercle at the base of the cornea on the inner side of the peduncle, and a minute projection further proximally. The distal segments of the antennular peduncles, the tips of the antennal scales, the third maxillipedes, and the legs except the fourth pair in the larger specimen, are all missing. The exopod of the uropod is a little less than five times as long as wide; the ciliated part of its external margin is somewhat less than one-sixth the length of the margin, and is separated from the unciliated part by a well-developed tooth.

The thelycum lacks an operculum; the medially incised posterior lip of the receptacular atrium thus overlies the anterior lip instead of being overlain by it.

Color in Formalin: Cornea of eyes pale chocolate-brown with dark internal area; median lobe of ocular somite with a black fleck. Mouthparts carmine with golden-brown setae; stomach and oesophagus deep carmine; leg-bases and ridges of pereionic sternites pale vermilion. Gastric gland cream-colored. Otherwise white (transparent-translucent in life?). The extreme oiliness of the gastric gland seems worthy of mention.

Remarks: *Petalidium suspiriosum* appears to differ from all other described material of the genus in that the rami of the anterior arthrobranchs of IX-XII may bear as many as twelve lamellae, instead of "généralement cinq ou six par série" (Hansen, 1922, p. 189); and particularly in that there are two gills instead of one on XIII, of which the anterior is large and well developed rather than "rudimentaire ou rien."

P. suspiriosum differs further from *P. obesum* Kr. as described by Hansen, 1922, in the following particulars: In *P. obesum* the integument is stated to be "en outre réticulé;" the cervical sulcus is scarcely visible; both supra-orbital and hepatic spines are absent; there is no second tubercle proximal to the well-developed one at the distal end of the inner margin of the ocular peduncle; and the lips of the receptacular atrium of the female are covered by a well-developed operculum with convex posterior outline. It may be noted that in the lack of an operculum the thelycum of *Petalidium suspiriosum* resembles that of *Sicyonella* and of *Acetes* (Burkenroad, 1937, p. 509).

With regard to the other named species of the genus, *P. foliaceum* Bate, the available information is somewhat fragmentary and is so contradictory as perhaps even to indicate the existence of still another species of *Petalidium*. According to Bate, 1888, p. 349, Hansen, 1903, p. 54, and Illig, 1914, p. 373, the thirteenth somite lacks a gill completely in the eight adult or subadult specimens of *Petalidium* examined by these authors, all of which had been captured in subantarctic waters. Hansen, 1903, suggests that certain larval specimens of *Petalidium* including the type of *Sergestes obesus* Kroyer, in which the rudiment of a gill is present on XIII, may represent a species distinct from the adults then known in which this gill is always

absent; subsequently, Hansen (1922, p. 193) finds frequently but not always "une branchie rudimentaire" on XIII among twenty specimens taken in the temperate or tropical North Atlantic which he consequently distinguishes from *P. foliaceum* under the name *P. obesum* (Kroyer). Unfortunately, Hansen characterizes *P. foliaceum* only with the somewhat indefinite remarks that by reason of the absence of the rudimentary gill of XIII in some individuals of *P. obesum*, the presence only of this rudiment "peut compter comme caractère specique positif;" and that the figures of the petasma of subantarctic specimens, presumably of *P. foliaceum*, by Illig, 1914, and Stebbing, 1914, are in substantial agreement each with the other but different from Hansen's own figures of *P. obesum* "par plusieurs particularités".

Since the publication of Hansen's discussion, Illig, 1927, p. 283, has published a figure of the petasma of a specimen of *Petalidium* taken in the South Atlantic not far north of the previous records of *P. foliaceum*, which agrees very well with Hansen's figures of *P. obesum*. Illig, who seems not to have been aware of Hansen's later studies, and who does not discuss the branchial or carapacic characters of this particular male, reports his specimen as *P. foliaceum* without remarking that the petasma differs from that which he had previously figured under the same name. This difference between two figures referred by their author to the same species seems a good demonstration that two forms of petasma actually occur in the material of *Petalidium* previously known. The chief difference between these two forms of petasma seems to be that the distal, posterior lobule of lobus armatus of pars media is in *P. obesum* much smaller and less heavily armed than is the proximal, anterior lobule; whereas in *P. foliaceum* the distal, posterior lobule is the larger and more heavily armed of the two branches.

According to Bate, and to Hansen, 1903, p. 55, the *Challenger* specimens of *P. foliaceum* have neither hepatic nor supraorbital spines; the cervical sulcus is well developed; and the ocular peduncle sometimes bears two tubercles on its inner margin. According to Illig, 1914, the carapace of his specimens of *Petalidium*, which from his figure of the petasma seem referable to *P. foliaceum*, bears a well-developed cervical sulcus and (in contrast to Bate's and Hansen's specimens) both hepatic and supra-orbital spines; the ocular peduncle has two tubercles on its inner margin. Stebbing's description (1914, p. 284) of a specimen which by its petasma seems referable to *P. foliaceum* takes no account of the carapacic features or of the branchial formula, but his undetailed figure seems to indicate a well-developed cervical sulcus, and he states that the ocular peduncle bears two tubercles.

The above contradictory or incomplete accounts of *Petalidium foliaceum* seem to require, in the absence of information as to the female genitalia of this species or of the petasma of *P. suspiriosum*, that the distinction of these two forms must for the present rest entirely upon the difference in branchiae, which however seems so great (XIII with two gills in *P. suspiriosum;* without any in *P. foliaceum*) as to provide an excellent diagnostic.

Petalidium suspiriosum displays considerable superficial resemblance to *Sergestes mollis* Smith and *S. inous* Faxon, from which, however, it can instantly be distinguished by the quite different appearance of its anterior arthrobranchs which are composed of fewer but larger rami, by the presence of an hepatic spine on the sides of its carapace, by the absence of more than one pair of lateral spinules on its telson, by its shorter but larger eyes with distomedially tuberculate peduncle, etc.

It seems possible that "*Sergestes* sp. indet." of Rathbun, 1904, p. 146, and Schmitt, 1921, p. 20, a female of about 38 mm. taken in 417 fathoms off San Diego, California, may refer to *Petalidium*. The extreme mutilation of the specimen, which is "without maxillipeds or trunk-legs," and which "resembles *S. mollis* Smith" but possesses "a minute hepatic spine," is suggestive of the present species.

LUCIFER Thompson.

Lucifer typus H. M. Edwards.

Leucifer typus, H. M. Edwards, 1837, p. 469.
Lucifer typus, Hansen, 1919, p. 53; Cecchini, 1928.
? *Lucifer acestra*, Faxon, 1895, p. 214.

Range: Atlantic; Indo-Pacific; eastern North Pacific including Gulf of California. Surface (and midwater?).

Material: Two specimens were taken in the mouth of the Gulf of California, in 400 fathoms, as follows: Station 159: T-2 (2 ♂). Cat. No. 361,044.

Dimensions and Sexual Condition: Both specimens are sexually mature males measuring about 9.6 mm. in total length.

Remarks: No differences from Hansen's description are perceptible. It seems worth remarking that the scarlet spherule which occurs in the telson of *L. typus* and *L. faxoni* Borradaile of the genus at least, seems from the dissection of formalin material to be not a simple pigment spot but a ball of cells invested with a tunic of chromatophores.

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26.

Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Serrivomeridae. Part II: Genus *Platuronides*.[1]

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(Text-figures 1-14).

INTRODUCTION.

For detailed data in regard to nets, locality, dates, etc., concerning the capture of the deep-sea eels treated in this monograph, refer to *Zoologica*, Vol. XIII, Nos. 1, 2 and 3 and Vol. XX, No. 1, pp. 1-2. For physical data, methods of measurement and definitions of growth stages, see *Zoologica*, Vol. XVI, No. 1. The genus *Serrivomer* has been discussed in *Zoologica*, Vol. XX, No. 3. A definition and discussion of the family Serrivomeridae will be found at the end of the present paper (p. 346).

The drawings in the present paper are the work of George Swanson.

Genus *Platuronides* Roule and Bertin, 1924.

Generic Characters (*Adults*): Snout less than half length of head; gradually tapering, not sharply constricted in front of eye; vomerine teeth conical or compressed, widely or not widely separated but not forming a ridge as high or as continuous as in *Serrivomer*. Trunk decreasing gradually in height and thickness from shoulder to tail; no nuchal constriction; no caudal filament; jaws strong, the lower slightly the longer; maxillary and mandibular teeth small, pointed, in one to six rows; structure and arrangement of vomerine teeth various, as mentioned above; nostrils tubular or non-tubular; pectorals vestigial; dorsal beginning well behind pectorals and continuing to tip of the tail; anal origin immediately behind anus, at a distance about mid-way between pectoral base and dorsal origin, and continuing to the end of the body; posterior portions of dorsal and anal fins relatively rigid with densely crowded rays which form, with the rudimentary true caudal fin, a semi-rhombic pseudo-caudal; about 50 anal rays in the last 3.5 per cent. of the total length of the fish, and more than 50 rays occupying a space per ray of less than one-tenth of 1 per cent. of the total length; lateral line without pores.

Young transitional adolescents (elvers) of *Platuronides*, in which the specialized development of dorsal and anal rays is not yet conspicuous, can be told at a glance from *Serrivomer* of similar length by the compression of the posterior part of the body, as opposed to its roundness in *Serrivomer*,

[1] Contribution No. 546, Department of Tropical Research, New York Zoological Society. Contribution, Bermuda Biological Station for Research, Inc.

and by the lack of silvery pigmentation, which is pronounced in immature *Serrivomer.*

Discussion: Three species of *Platuronides* have been described, all from Bermuda and the Bahamas, two of them having been taken by the Bermuda Oceanographic Expeditions.

Platuronides danae, described from a single 486 mm. specimen taken in the Bahamas, and since taken off Bermuda by the present expeditions, is a perfectly distinct species characterized by having the vomerine teeth all conical, widely separated and set in a single line, and by having the anterior nostril tubular.

Platuronides ophiocephalus and *P. acutus,* however, both described by Parr in 1932 from single specimens taken off Bermuda, may very possibly prove to be synonymous for the following reasons: The two species differ from each other chiefly in the dentition, which, in *P. ophiocephalus,* consists of fewer teeth more regularly arranged than in *P. acutus;* however, the type specimens measured, respectively, 632 mm. and only 220 mm. in length, and our studies on the development of the teeth in *Serrivomer* (see *Zoologica,* Vol. XX, No. 3) have shown similar and equally radical differences in the teeth of specimens of different sizes; furthermore, the largest specimens of *P. acutus* in the present collection are smaller than the type and, though plainly referable to this species, show still more teeth, even less regularly arranged. Again, the differences in proportions, including the major one of the width between sphenotic prominences ("less than 20 per cent greater than the interorbital width" in *P. ophiocephalus,* and "about 40 per cent greater" in *P. acutus*) also may easily be growth characters; it is more than 40 per cent greater in our specimens which, as has been said, are all smaller than the type. As a final, but slight, indication of synonymy, it may be mentioned that all of the leptocephali of this genus taken by us off Bermuda plainly belong to only the two species, *P. danae* and *P. acutus.* Definite synonymy, however, cannot be established until specimens intermediate in size between the two type specimens have been secured.

An additional specific character found in the present specimens is the vertebral count, about 165 to 170 in *P. danae* and about 153 to 158 in *P. acutus.*

Larvae: The leptocephalus of *Platuronides* resembles that of *Serrivomer,* having the same type of snout, total number of myomeres (about 153 to 168) and the same posterior position of the anus. In addition, it metamorphoses at about the same length, the largest larvae of both genera being 61 and 62 mm. long. *Platuronides* leptocephali differ, however, from those of *Serrivomer* as follows:

1. There are 102 to 125 pre-anal myomeres, not 89 to 97 (as in *S. beanii*).

2. The younger larvae (between 18 and 40 mm. in length[2]) are more slender than corresponding stages of *Serrivomer,* the maximum depth, excluding gut and finfolds, being contained 10 to 17 times (6 to 10 per cent.) in the length, instead of 7.8 to 8.3 (12 to 13 per cent.). The extreme larval range of depth is 8.4 to 17 (6 to 12 per cent.) in the length in *Platuronides,* and 7.8 to 9.6 (10.4 to 13 per cent.) in *Serrivomer.*

3. Pigment spots are present only on either side of the midline far back on the tip of the tail and, farther forward, in a single row, below the midline, where not more than half a dozen, well separated, are scattered before and behind the level of the anus. The anterior five of these chromatophores are quite constant in position, occurring at or near the 96th, 104th, 113th, 122nd and 130th myomeres; they may be designated by the letters A, B, C, D and E, respectively. Some or all of the series, however—es-

[2] No specimens shorter than 18 mm. were taken.

pecially chromatophore A—may be minute or lacking, particularly in large specimens; also it frequently happens that a chromatophore is visible on only one side of the body; a final variable factor is the distance of the pigment spot from the midline.

Unlike the arrangement in *Serrivomer*, chromatophores are entirely lacking both along the base of the anal fin and in oblique series outlining the myomeres.

Leptocephali of *P. acutus* in the present collection measure between 18 and 62 mm. in length, while those of *P. danae* range from 31 to 61 mm. Within these limits, the following key is applicable:

Pre-anal myomeres 108 to 115[3]; anus between chromatophores C and D, or, in smallest specimens, B and C............................ *P. acutus*

Pre-anal myomeres 122 to 125; anus between chromatophores D and E.. *P. danae*

Platuronides danae Roule and Bertin, 1924.

Specimens Taken by the Bermuda Oceanographic Expeditions.

7 specimens; May to September, 1929 to 1931; 50 to 1,000 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.; standard lengths from 31 to 488 mm.

Specimen Previously Recorded.

1 specimen; about 350 fathoms; off Bahama Islands; length 486 mm.

Description of Adult.

(Text-figs. 1, 2C).

(Based upon the description of the type, and upon the 488 mm. Bermuda specimen).

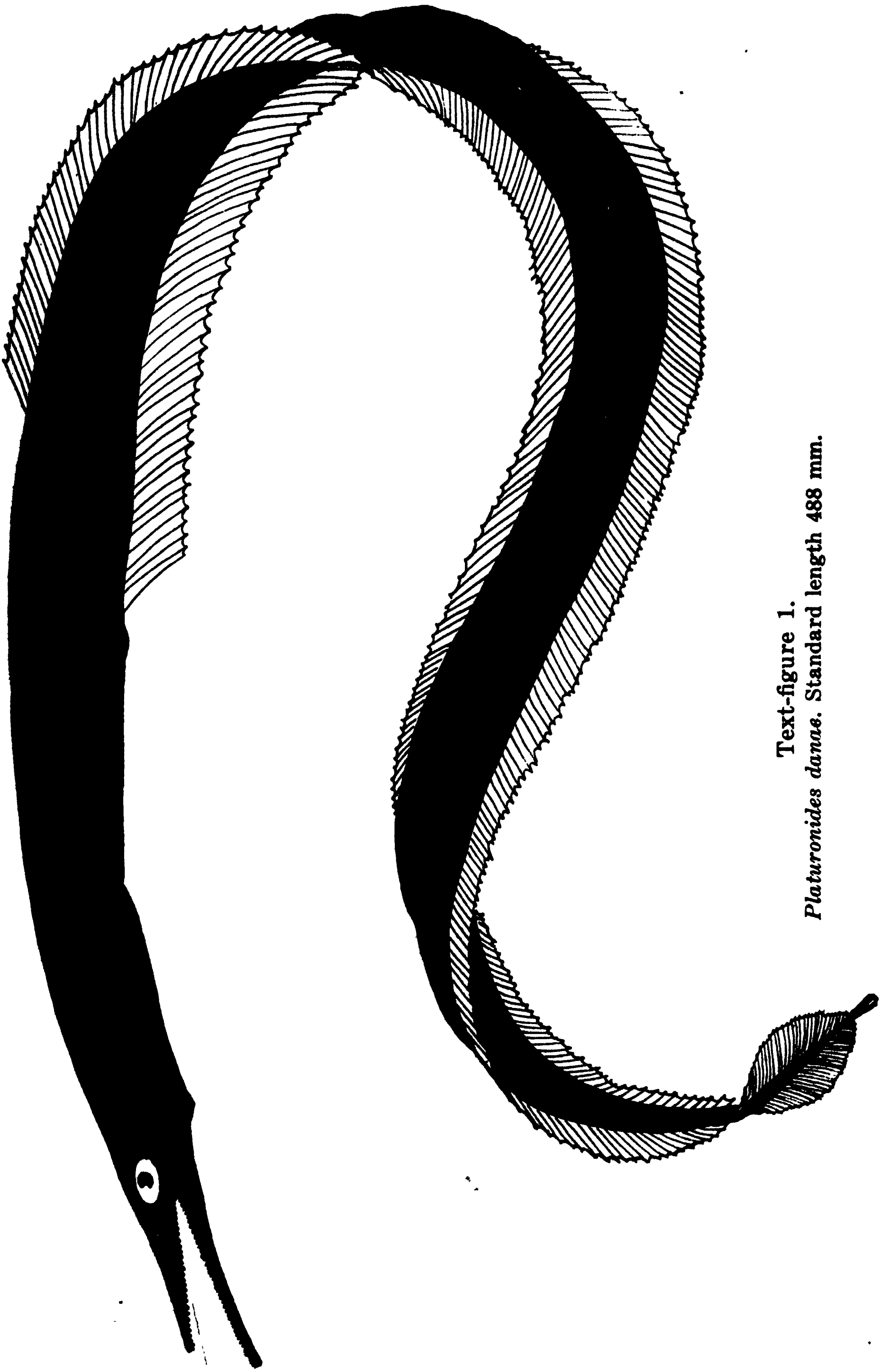
Color: The fresh Bermuda specimen was dark bronze, finely dotted with black specks. Of the type specimen, Roule and Bertin write (1929, p. 50): "La coloration est noirâtre, sans reflets irisés, avec le ventre plus foncé que le dos. Les iris sont bleuâtres." It is probable that these notes were made upon the preserved specimen, in which case the lack of iridescence is easily explained. On the other hand, the difference may be sexual: the Bermuda specimen is a male; the sex of the type is not stated.

Proportions: Maximum depth (immediately behind head) in length 33.5 to 35 (2.9 to 3 per cent.); head in length 6.1 to 6.3 (16.4 to 16.5 per cent.); eye (horizontal) in head 11 to 12.4 (1.3 to 1.5 per cent. of length); snout in head 3.4 to 3.45 (4.7 per cent. of length); lower jaw slightly longer than upper; vomer projecting less than one-sixth length of snout beyond tip of maxillary; interorbital width in length 69 to 70 (1.43 to 1.44 per cent.); intersphenotic width in length (Bermuda specimen only) 51 (2 per cent.); intersphenotic width 26 per cent. greater than interorbital width; snout to dorsal origin in length 2.9 to 3 (33 to 34 per cent.); snout to anal origin in length 3.75 to 3.8 (26 to 27 per cent.).

Nostrils: Anterior nostril tubular.

Teeth: (Text-figs. 3-5). The maxillary teeth of the type specimen are described (*loc. cit.* p. 49) as occurring in a single row in each ramus, and as being quite long and pointed, their length equalling about one-eighth the

[3] Except in 18 mm. specimen, which has only 102 pre-anal myomeres, though typical in every other way.



Text-figure 1.
Platuronides danae. Standard length 488 mm.

vertical diameter of the eye; about 50 maxillary teeth are shown in the figure in each ramus. Before clearing and staining, the teeth of the 488 mm. Bermuda specimen agreed very well with this description. Afterwards, however, it was evident that, in addition to the 39 to 42 teeth in a row in each maxillary ramus, there is an outer series of minute denticles, in an irregularly double row.

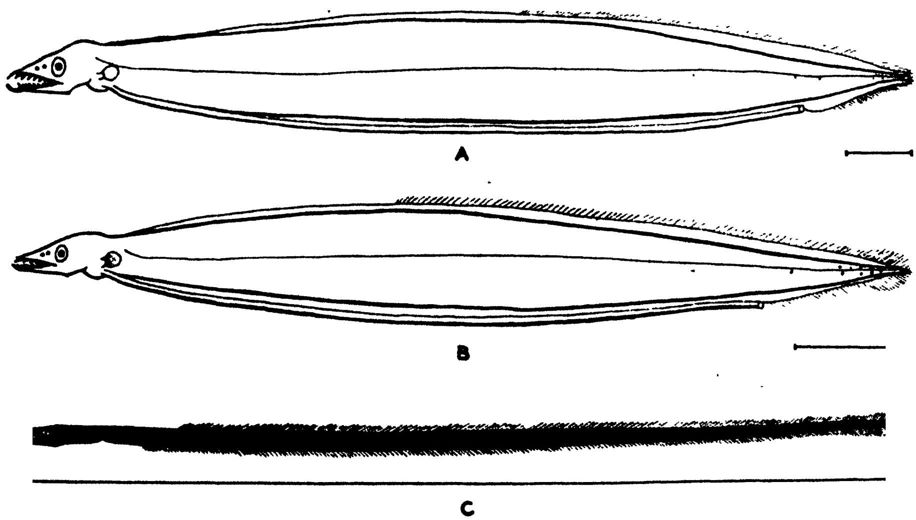
The mandibular teeth, not mentioned in the type description, number 39 to 44 in each ramus in the Bermuda specimen, all except three or four being set in a practically straight line on the outer margin of the jaw. The top of the latter bone is broad and flat, and along its inner margin, well separated from the row of teeth, is a row of very minute denticles, broken by several full-sized teeth in each jaw. This row is evidently the remains of a regular row of teeth such as is found in *Serrivomer*. Traces of a third, median row are also present. The full-sized mandibular teeth are twice as long as the longest teeth in the maxillary and, like them, are conical with the tips slightly recurved.

There are 16 teeth on the vomer, arranged in an irregularly single line. The anterior nine are relatively small and close set, and similar to those of the maxillary in size and shape. The posterior seven, however, representing the vomerine ridge of *Serrivomer*, are broad, flat, as long as the mandibular teeth, and well separated from each other. There are a number of marks of lost teeth on the vomer.

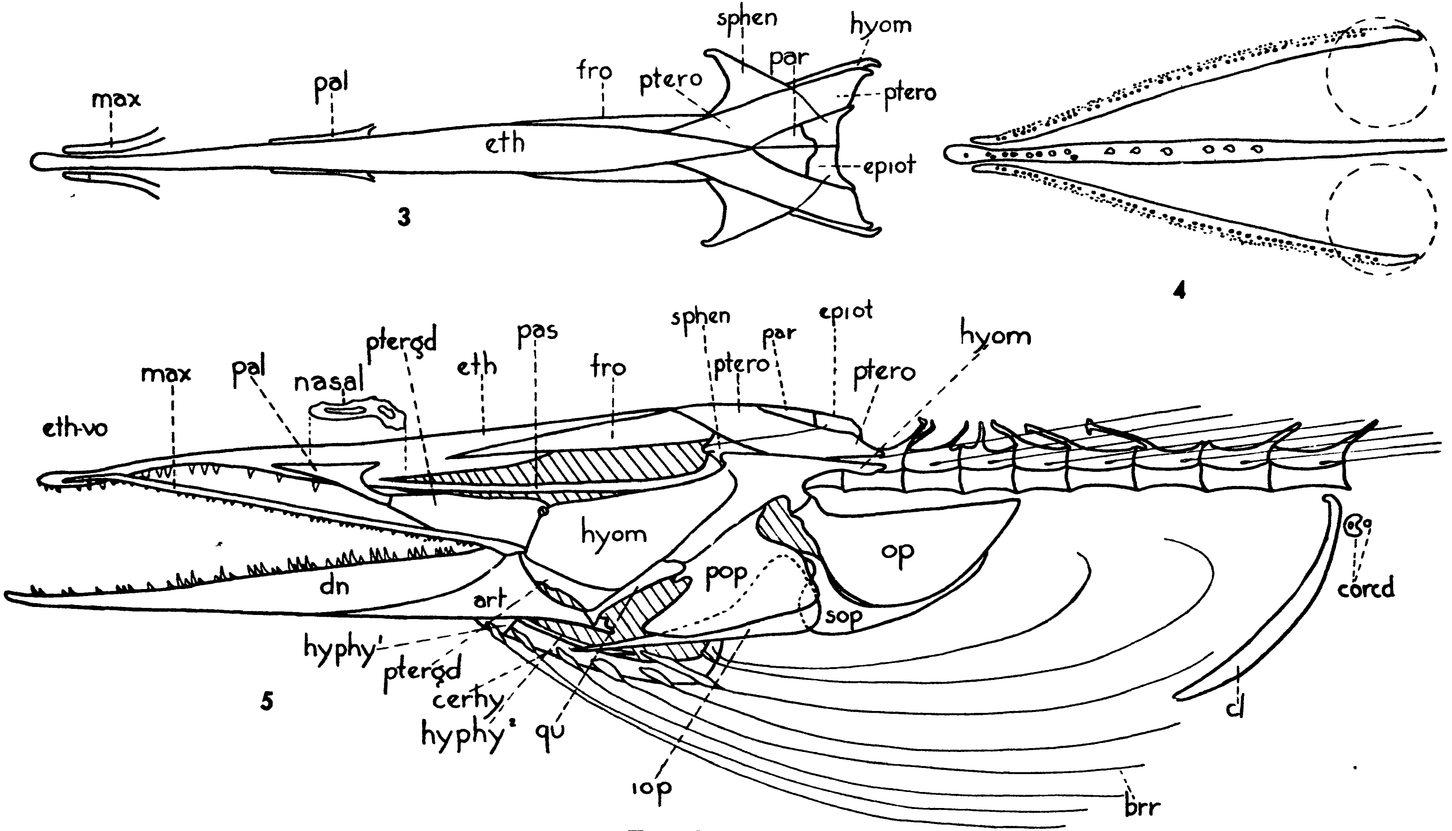
Fins: Pectoral rays 6 or 7, equal in length to vertical diameter of eye, inserted at upper angle of branchial clef. Dorsal rays 170, anal rays 166 in type, about the same in Bermuda specimen.

Osteology: (Text-figs. 3-7). The entire skeleton of *Platuronides danae*, as observed in the 488 mm. Bermuda specimen, is very similar to that of *Serrivomer*, both in relative positions of the bones and, in most cases, in their forms and proportions. The following differences may, however, be pointed out:

1. The skull of *Platuronides danae* is both longer and broader than that of *Serrivomer*. This is due chiefly to the greater extent of the pterotics.

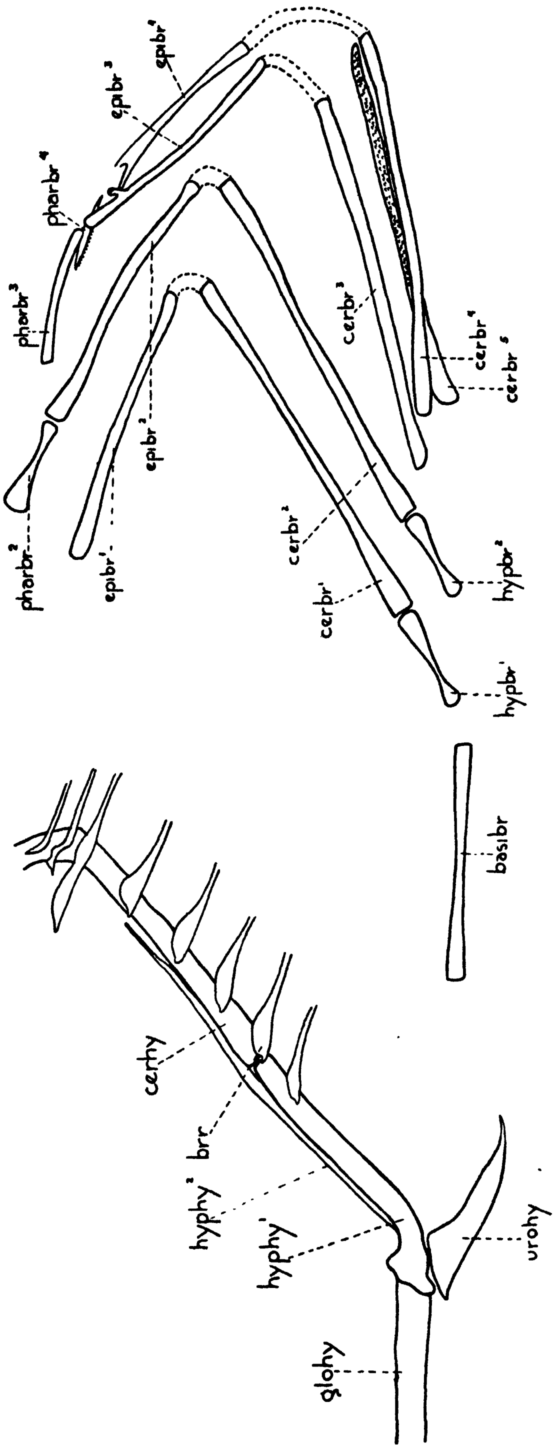


Text-figure 2.
Platuronides danae. A, larva, 36 mm.; B, larva, 61 mm.; C, adult, 488 mm.



Text-figures 3-5.

Platuronides danae. **3.** Skull of adult, dorsal view; standard length 488 mm. (x 2.2). **4.** Same, teeth of upper jaw and vomer, ventral view. (x 2.2). **5.** Same, bones of head, pectoral girdle and anterior part of vertebral column, lateral view. (x 2.2).



Text-figure 6.
Platuronides danae. Hyoid and branchial apparatus of adult, standard length 488 mm. (x 3.9).

2. The ethmo-vomer, correlated with the lighter burden of the teeth, is more slender.
3. The maxillary in this species and, according to Parr (1932, p. 6) in *P. ophiocephalus*, extends almost to the tip of the ethmo-vomer, instead of ending far behind it, as in *Platuronides acutus* and in both species of *Serrivomer* studied.
4. The articular and interopercular are both larger than in *Serrivomer*.
5. The pharyngeal teeth are less highly developed.

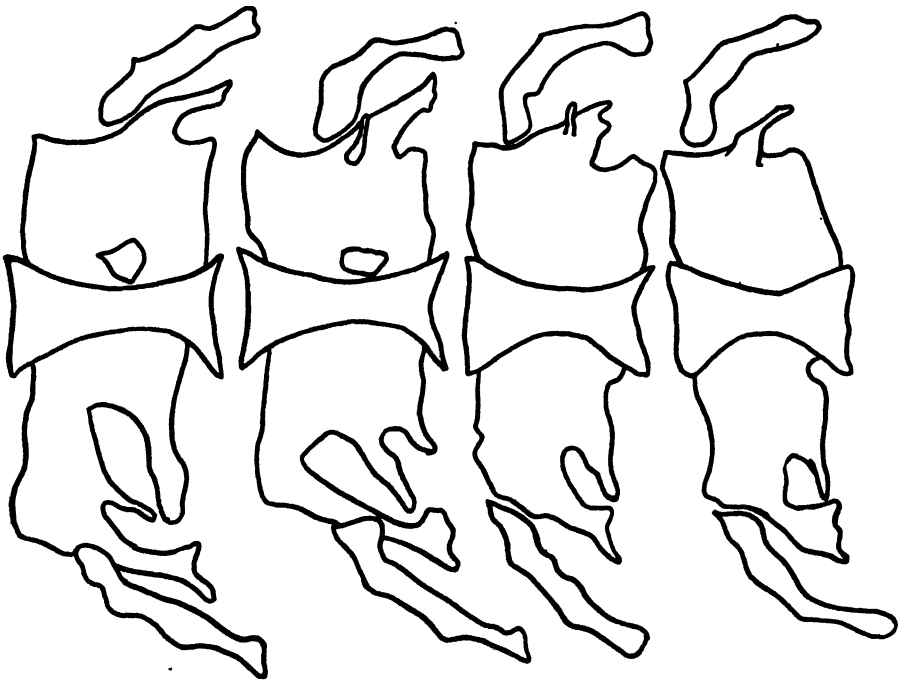
Unfortunately, the bones of the caudal fin fell to pieces in the process of clearing and staining, so that a study of them was impossible. However, a series of typical vertebrae near the tail (about the 161st to 164th), is shown in Text-fig. 7. The strength of the neural and haemal elements, for the purpose of the powerful posterior portions of the dorsal and anal fins, is apparent when compared with the slightness of corresponding elements in *Serrivomer* (*Zoologica*, Vol. XX, No. 3, Fig. 33).

Coelomic Organs: (Text-fig. 8). The coelomic organs of the 488 mm. specimen of *P. danae* differ from those of *Serrivomer* in that the liver is more extensive and the kidneys and gonads both extend farther posteriorly. While all of the specimens of *Serrivomer* examined were females, the adult *Platuronides danae* was a male, not in breeding condition.

Development.

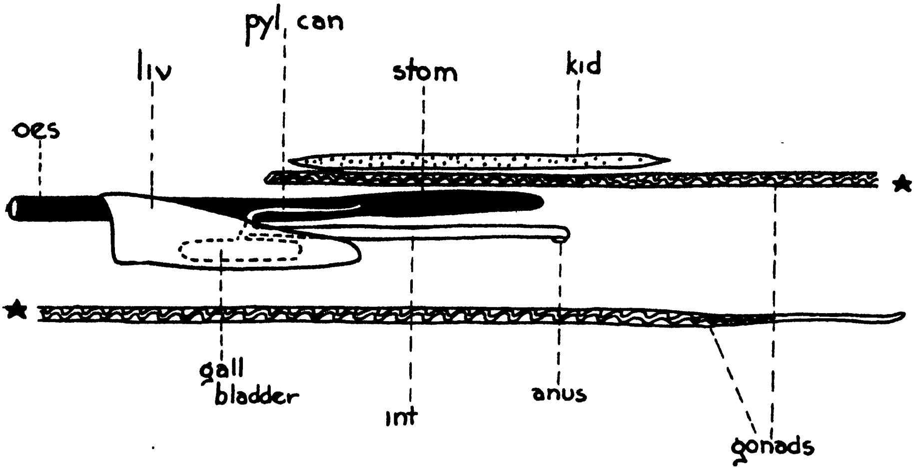
(Text-fig. 2).

The collection contains six moderately advanced larvae, measuring between 31 and 61 mm. in length in addition to the single adult, 488 mm.



Text-figure 7.

Platuronides danae. Vertebrae and fin supports of adult, standard length 488 mm., near base of tail (vertebrae about 161st to 164th). (x 78).



Text-figure 8.

Platuronides danae. Viscera of adult, standard length 488 mm.; oes: oesophagus; stom: stomach; liv: liver; int: intestine; kid: kidney. The kidneys were damaged so that it was impossible to trace the course of their ducts. (x .5).

long, described above. The characteristics of the larvae are described on pp. 332 and 333.

Ecology

Seasonal and Vertical Distribution: The present material is insufficient for the drawing of any conclusions. It may be remarked, however, that five of the six larvae, measuring between 31 and 38 mm. in length, were taken during July of three different years; the sixth larva, measuring 61 mm., was caught in August and the 488 mm. adult male in May. The larvae occurred between 50 and 900 fathoms, the adult male at 1,000 fathoms.

Abundance: *Platuronides danae* is one of the rarest of all Bermuda deep-sea fishes.

Study Material.

The following list gives the catalogue number, depth in fathoms, date of capture, length and growth stage of each specimen of *Platuronides danae* taken by the Bermuda Oceanographic Expeditions. All were caught in the cylinder of water off the Bermuda coast described in *Zoologica,* Vol. XVI, No. 1, p. 5.

No. 10,292; Net 145; 1,000 F.; May 31, 1929; 488 mm.; Adult.
No. 11,866; Net 329; 800 F.; July 27, 1929; 37 mm.; Larva.
No. 11,867; Net 330; 900 F.; July 27, 1929; 36, 38 mm.; Larvae.
No. 12,967; Net 412; 800 F.; Sept. 3, 1929; 61 mm.; Larva.
No. 17,039; Net 801; 900 F.; July 15, 1930; 33 mm.; Larva.
No. 21,325a; Net 1075; 50 F.; July 11, 1931; 31 mm.; Larva.

References.

Platuronides danae:

Roule & Bertin, 1924. p. 61. (Preliminary description of type specimen).

Roule & Bertin, 1929, p. 48; pl. I, fig. 3; text-figs. 32-34. (1 specimen; 486 mm.; 25° 35′ N. Lat., 74° 45′ W. Long.; about 600 metres—1,000 metres of wire; *type specimen*).

Parr, 1932, p. 5. (Key to the species of *Platuronides*).

Platuronides acutus Parr 1932.

Specimens Taken by the Bermuda Oceanographic Expeditions.

22 specimens; April to September, 1929 to 1931; 100 to 1,000 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.; standard lengths from 18 to 178 mm.

Specimen Previously Recorded.

A single specimen; at about 850 fathoms? (10,000 feet of wire); off Bermuda; length 220 mm.

Description of Largest Known Specimens.

(Text-fig. 9F).

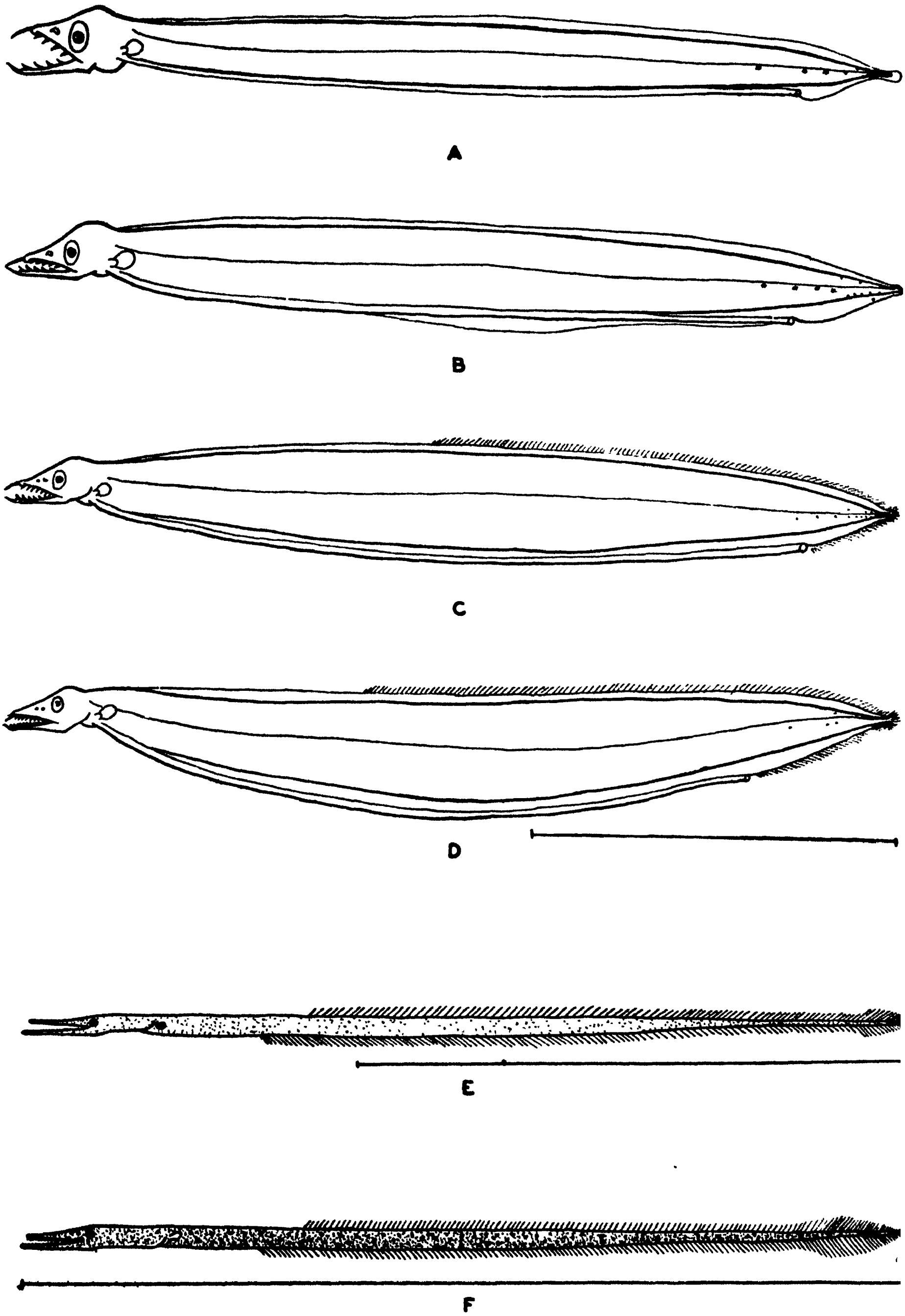
(Based upon the description of the type, and upon two transitional adolescents of the present collections, measuring 133 and 178 mm. in length, respectively).

Color: Dark brownish black, with no trace of the silvery skin characteristic of *Serrivomer*. Skin dotted with black chromatophores.

Proportions: Maximum depth (immediately behind head) in length 40 to 50 (2 to 2.5 per cent.); head in length 6.1 to 6.5 (15.5 to 16.5 per cent.); eye (horizontal) in head 16 to 24 (0.7 to 0.9 per cent. of length); snout in head 2.7 to 2.8 (5.5 to 6 per cent. of length); lower jaw slightly longer than upper; vomer projecting about one-third length of snout beyond tip of maxillary; intersphenotic width 40 to 60 per cent. greater than interorbital width; interorbital width in length 77 to 102 (.98 to 1.3 per cent.); intersphenotic width 56 to 62 in length (1.6 to 1.8 per cent.); snout to dorsal origin in length 3 to 3.2 (31.5 to 32 per cent.); snout to anal origin in length 3.7 to 4 (25 to 27 per cent.).

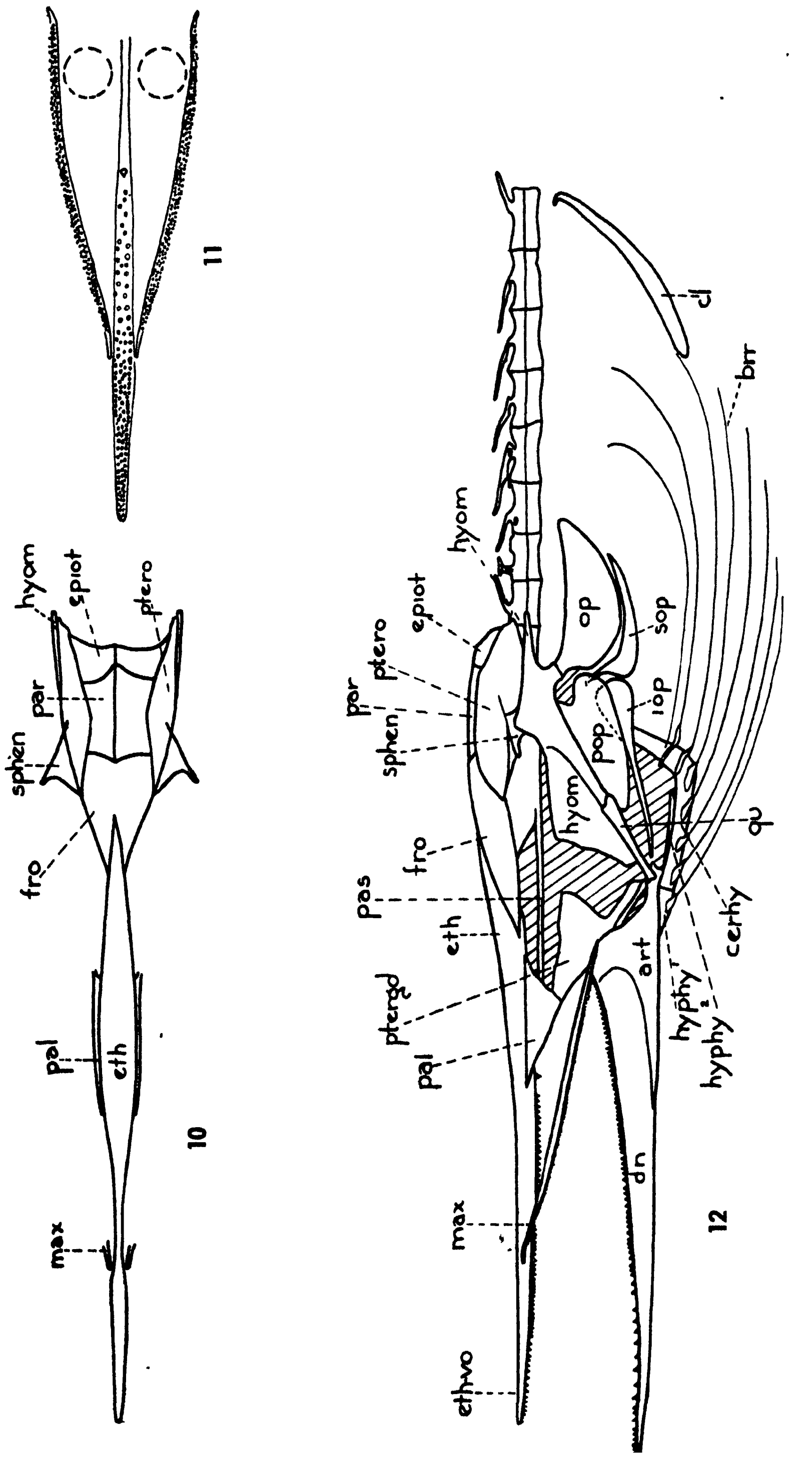
Nostrils: Non-tubular.

Teeth: (Text-figs. 10-12). The maxillary and mandibular teeth are numerous, small and pointed and arranged in from three to six irregular rows; in the mandible they are slightly larger than in the maxillary. In the 220 mm. type specimen, Parr (1932, pp. 9-10) describes the vomerine teeth thus: "Anterior portion (head) of vomer with a band of numerous small, irregularly scattered, conical teeth, about 5 or 6 wide at the broadest part, with the teeth nearest to the median somewhat larger than the others. Posteriorly these teeth become gradually larger and more compressed, and continue as a double row of alternating, compressed and somewhat decurved teeth on the shaft of the vomer. There are about 40-60 teeth in a longitudinal count on the anterior part of the vomer, depending upon the manner in which they are counted, and the posterior row on the shaft has about 8-9 teeth on each side of the median. While the latter are larger than the conical teeth on the anterior portion, they are not so large, nor quite so broad and compressed, as those of *P. ophiocephalus* or of *Serrivomer*, and their free portions do not overlap in the lateral view to nearly the same extent as in the latter forms. The anterior conical dentition also extends much farther backward in *P. acutus*, so that the posterior compressed series



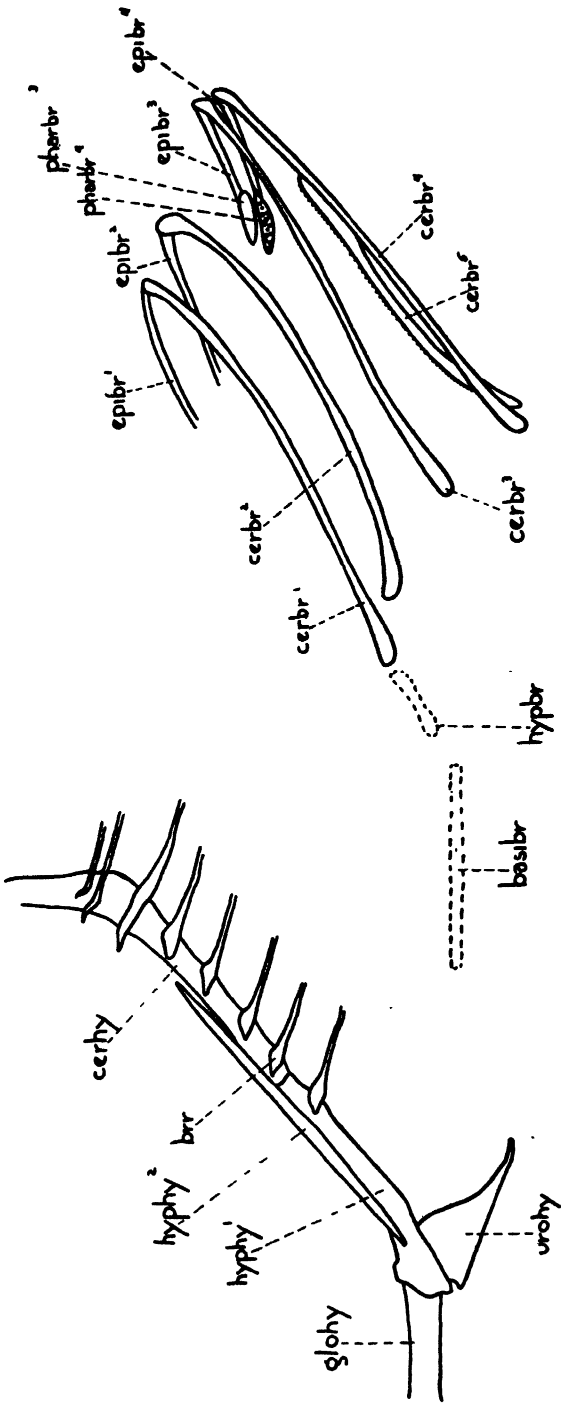
Text-figure 9.

Platuronides acutus. **A** to **D**, incl., larvae, 18, 26, 40 and 56 mm., respectively; **E**, adolescent, 92 mm.; **F**, transitional adolescent, 133 mm.



Text-figures 10-12.

Platuronides acutus. **10.** Skull of transitional adolescent, dorsal view; standard length 133 mm. (x 6.8). **11.** Same, teeth of upper jaw and vomer, ventral view. (x 6.8). **12.** Same, bones of head, pectoral girdle and anterior part of vertebral column, lateral view. (x 6.8).



Text-figure 13.

Platuronides acutus. Hyoid and branchial apparatus of transitional adolescent, standard length 133 mm. (x 14.6).

is relatively much shorter than in *P. ophiocephalus* . . . although the vomerine dentition reaches almost to the eyes in both." In the most advanced specimens of the present collection, all smaller than the type, the teeth of the posterior part of the vomer differ less from those of the anterior part, are scarcely larger, only slightly flattened, well separated and do not yet form a regular series (see Text-fig. 11). Similar developmental stages were found in *Serrivomer*. Also, relatively more of the vomer protrudes than in the type—another growth character which is common to both genera.

Fins: Pectoral rays 6 to 8, equal in length to vertical diameter of eye, inserted at upper angle of branchial cleft; dorsal rays about 185 to 190; anal rays about 180 to 185.

Osteology: (Text-figs. 10-14). The small size of the specimen studied (133 mm.) makes difficult comparison with the large specimens of *Platuronides danae* and of *Serrivomer* which have been studied, since all of these measure around 500 mm. in length. The following points, however, are evident: The differences given on p. 335 between *P. danae* and *Serrivomer* are true of *P. acutus* also, except that the maxillary extends farther anteriorly. The relatively greater extent of parietals and frontals, and the lesser spread of such elements as the hyomandibular and the dorsal laminae of the sphenotic are obviously due to the specimen's immaturity (cf. *Serrivomer, Zoologica,* Vol. XX, No. 3, Figs. 26-31 and 37-40).

Since the size of the specimen is even more important in a study of the vertebral column and caudal fin than of the osteology of the head, no comparison at all can be made between these regions in *P. acutus* and in *P. danae* and *Serrivomer*.

DEVELOPMENT.

(Text-fig. 9).

Material: The collection consists of larvae, adolescents and transitional adolescents, as follows:

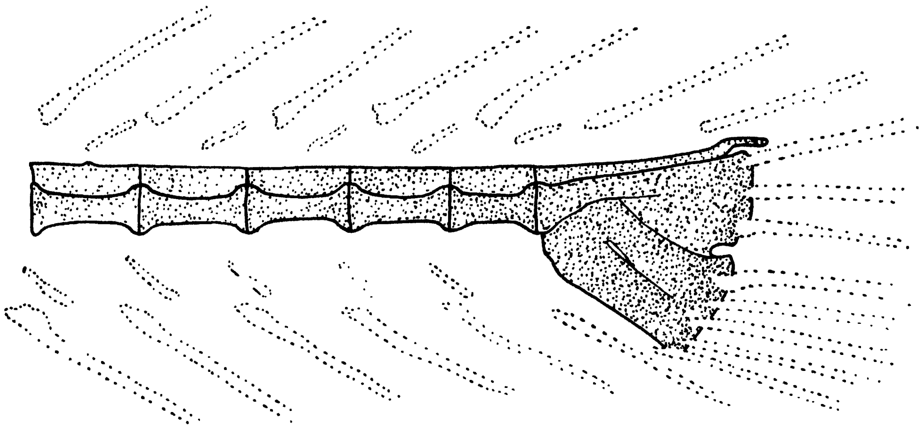
Larvae, 18 to 62 mm.: 14 specimens.
Adolescents, 90, 92 mm.: 2 specimens.
Transitional Adolescents, 70 to 178 mm.: 6 specimens.
Total: 22 specimens.

Discussion: The characteristics of the larvae are described on pp. 332 and 333. Save for the difference in the position of the anus (at the 102nd to the 125th myomere, not between the 89th to 97th), the Key to the Growth Stages under the discussion of *Serrivomer* (*Zoologica,* Vol. XX, p. 80), serves very well for *Platuronides*. The shortness (70 mm.) of one of the present transitional adolescents is noteworthy: it may indicate a shrinkage of 20 mm. during the adolescent stage, or simply an unusually short elver. Evidences of the characteristic pseudo-caudal are not apparent until adolescence.

ECOLOGY.

Seasonal and Vertical Distribution: More than two-thirds of the specimens were taken in June and July, although the material is not sufficient to serve as a basis for conclusions. The larvae occurred between 100 and 1,000 fathoms, adolescents at 600 and 700 fathoms and transitional adolescents between 500 and 1,000 fathoms.

Abundance: *Platuronides acutus* is rare among the deep-sea fishes of Bermuda.



Text-figure 14.
Platuronides acutus. Posterior part of vertebral column and base of caudal fin in transitional adolescent, standard length 133 mm. (x 70).

Study Material.

The following list gives the catalogue number, depth in fathoms, date of capture, length and growth stage of each specimen of *Platuronides acutus* taken by the Bermuda Oceanographic Expeditions. All were caught in the cylinder of water off the Bermuda coast described in *Zoologica,* Vol. XVI, No. 1, p. 5. "Trans. Adol." stands for "Transitional Adolescent."

No. 9,625a; Net 41; 600 F.; April 25, 1929; 92 mm.; Adolescent.
No. 9,879; Net 89; 600 F.; May 10, 1929; 120 mm.; Trans. Adol.
No. 10,257; Net 140; 500 F.; May 31, 1929; 123 mm.; Trans. Adol.
No. 10,272; Net 144; 900 F.; May 31, 1929; 70 mm. Trans. Adol.
No. 11,152; Net 239; 600 F.; June 29, 1929; 30 mm.; Larva.
No. 11,281; Net 256; 700 F.; July 7, 1929; 92 mm.; Adolescent.
No. 11,400; Net 277; 1,000 F.; July 9, 1929; 178 mm.; Trans. Adol.
No. 11,459; Net 283; 1,000 F.; July 10, 1929; 42 mm.; Larva.
No. 11,563; Net 302; 1,000 F.; July 13, 1929; 38 mm.; Larva.
No. 12,589; Net 304; 500 F.; July 16, 1929; 62 mm.; Larva.
No. 11,647; Net 307; 800 F.; July 16, 1929; 29 mm.; Larva.
No. 11,698; Net 310; 600 F.; July 22, 1929; 40 mm.; Larva.
No. 11,745; Net 315; 500 F.; July 23, 1929; 133 mm.; Trans. Adol.
No. 12,114; Net 356; 700 F.; Aug. 8, 1929; 106 mm.; Trans. Adol.
No. 15,659; Net 658; 700 F.; June 2, 1930; 20 mm.; Larva.
No. 16,211; Net 730; 1,000 F.; June 26, 1930; 18 mm.; Larva.
No. 21,018a; Net 1043; 300 F.; June 26, 1931; 26 mm.; Larva.
No. 21,148; Net 1057; 100 F.; July 7, 1931; 29 mm.; Larva.
No. 21,156; Net 1059; 100 F.; July 8, 1931; 30 mm.; Larva.
No. 21,320; Net 1078; 300 F.; July 11, 1931; 33 mm.; Larva.
No. 23,038a; Net 1243; 700 F.; Aug. 31, 1931; 26 mm.; Larva.
No. 23,255; Net 1280; 900 F.; Sept. 9, 1931; 56 mm.; Larva.

References.

Platuronides acutus:

Parr, 1932, p. 8; text-figs. 4, 5. (1 specimen; 220 mm.; off Bermuda, 32° 24′ 15″ N. Lat., 64° 29′ W. Long.; 10,000-foot wire, *type specimen*).

Family SERRIVOMERIDAE.

Characteristics: Naked deep-sea eels with the body slender and the jaws moderately attenuated; snout less than half length of head; maxillary and mandibular teeth small, erect, pointed, set in one or more rows; vomerine teeth larger, erect, compressed or conical, in one or two rows; two pairs of large nostrils and three pairs of tiny ones, all set close in front of eye; anterior nostril tubular or non-tubular; nuchal constriction absent; gill openings present, confluent; anus in advance of middle of length; pectoral fins vestigial; dorsal fin rays short, feeble; anal rays longer; both dorsal and anal confluent with caudal, sometimes (in *Platuronides*) lengthened and strengthened posteriorly to form a spatulate pseudo-caudal; lateral line pores present or absent, never large or conspicuous; caudal filament absent.

Skeleton[4] moderately well developed; frontals and parietals paired, united by suture; supraoccipital absent; wing-like posterior processes on epiotics, pterotics and hyomandibulars; no conspicuous bony channels for sensory canal system; palato-pterygoid large and laminar; hyomandibular and quadrate forming with the mandible an angle of about 120°; mandible equal to or slightly longer than ethmo-vomer; ethmo-vomer projecting less than half the length of the maxillary beyond anterior tip of latter bone; hyoid, branchial and opercular apparatus complete, moderately well ossified; branchiostegal rays six to 12; supracleithrum absent; cleithrum and coracoids reduced; radials absent; vertical fins feebly supported, vertebrae moderately numerous, 143 to 171.

Coelom relatively small; intestine straight; a single caecal pouch; stomach black, a blind sac; liver small; kidney ending slightly behind anus; gonads dorsal, extending far behind all other organs.

Affinities: In most of their characteristics, the Serrivomeridae show distinctly less specialization than the Nemichthyidae: their jaws are shorter, bodies less attentuated, anus more posteriorly placed, palato-pterygoids well developed, opercular, hyoid and branchial apparatus complete, and vertebrae less numerous. However, in their teeth and vestigial pectoral fins they are even more highly specialized than the Nemichthyidae; it is interesting to note that in adolescent and young transitional adolescent serrivomerids the teeth, in numbers, shortness and banded arrangement, resemble those of older nemichthyids.

On the other hand, serrivomerids appear less advanced in every way than the cyemids. Their relation to *Avocettinops* Roule and Bertin (1924) and *Gavialiceps* Alcock (1889), as well as to the nearest non-nemichthyidiform groups, should prove to be of the greatest interest when these questions can be investigated through osteological studies.

Taxonomic Discussion: Five genera have been described which properly belong in this family: *Serrivomer* Gill and Ryder (1883), *Spinivomer* Gill and Ryder (1883), *Gavialiceps* Alcock (1889), *Platuronides* Roule and Bertin (1924) and *Paraserrivomer* Roule and Angel (1931). A sixth genus, *Stemonidium* Gilbert (1905), as Trewavas has pointed out (1932, p. 652), has the external characters of the serrivomerids, but the teeth of a typical nemichthyid.

The unique specimen of *Spinivomer*, a poorly described Atlantic form measuring only 147 mm. in length, has been temporarily mislaid at the United States National Museum. From the type description—which records it as bright silvery in color and as not having typical, compressed, vomerine teeth—it seems almost certain that this specimen will prove to be a young *Serrivomer* for the following reasons: first, at a similar length specimens of the latter genus are distinctly silvery, while corresponding specimens of

[4] From studies of *Serrivomer* and *Platuronides*.

Platuronides are already dusky; second, the vomerine teeth of *Serrivomer,* as pointed out in a previous paper (Beebe and Crane, 1936, p. 85), do not attain their characteristic form and arrangement until the fish has reached a length of at least 150 mm.

Gavialiceps, a poorly known genus from the Indian Ocean, is distinguished from *Serrivomer* chiefly by the lack of pectoral fins. As Roule and Angel (1931, pp. 2-3; 1933, p. 72), have remarked, it is likely that the fins have been destroyed or overlooked because of their delicacy, and that the genus is actually synonymous with *Serrivomer* or *Paraserrivomer.* We have already (Beebe and Crane, 1936, p. 62) recorded the fact that the Atlantic specimens referred to *Gavialiceps microps* Alcock by Borodin (1929, p. 74) are typical examples of *Serrivomer beanii.*

Paraserrivomer hasta (Zugmayer), 1911, first described as an Atlantic species of *Gavialiceps,* is distinguished from *Serrivomer* chiefly by spatulate enlargements on the tips of the jaws. These swellings are very similar to those found in the Nemichthyidae, although the genus is typically serrivomerid in every other respect.

The two remaining genera, *Serrivomer* and *Platuronides,* both represented in the Bermuda collection, have already been discussed at length in the present paper and in *Zoologica,* Vol. XX, No. 3. Parr's key to these two genera (1932, p. 5) has proved satisfactory in distinguishing larger specimens. Means of identifying the larvae and elvers are set forth in the present paper on pp. 331-333.

Note on Synonomy of *Serrivomer beanii.*

The 173 mm. Atlantic specimen referred by Borodin (1931, p. 73 and pl. V, fig. 3) to *Nemichthys* sp. has been examined by us at the Museum of Comparative Zoology and found to be a transitional adolescent example of *Serrivomer beanii.* The *Saccopharnyx*-like pouch formed by the expanded position of the hyoid apparatus can be observed in a number of *Serrivomer* in the Bermuda collection. Although the specimen is in poor condition, the character of the vomerine teeth and the anteriorly elongate branchiostegal rays leave no doubt as to its identity. This taxonomic correction should be added to the synonomy of *S. beanii* as given in *Zoologica,* Vol. XX, No. 3, pp. 61-63. (The present museum label of the specimen (M. C. Z. No. 32,299) is inscribed *"Nemichthys saccopharingoides* n. sp?").

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27.

Deep-sea Fishes of the Bermuda Oceanographic Expeditions. Family Nemichthyidae[1].

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(Text-figures 1-22).

INTRODUCTION.

For detailed data in regard to nets, locality, dates, etc., concerning the capture of the deep-sea eels treated in this monograph, refer to *Zoologica,* Vol. XIII, Nos. 1, 2 and 3, and Vol. XX, No. 1, pp. 1-2. For physical data, methods of measurement and definitions of growth stages, see *Zoologica,* Vol. XVI, No. 1.

The drawings are the work of George Swanson.

We wish Dr. L. P. Schultz and Dr. Thomas M. Barbour to accept our thanks for their cooperation in enabling us to examine specimens deposited in the United States National Museum and in the Museum of Comparative Zoology.

IMPORTANT POINTS IN THE FOLLOWING STUDY OF THE NEMICHTHYIDAE.

Taxonomy: 1. Contrary to recent opinions that the genus *Nemichthys* is mono-specific, we conclude that it contains at least two species, *Nemichthys scolopaceus* Richardson of cosmopolitan distribution, and *Nemichthys fronto* Garman from the eastern Pacific.

2. There are two valid Atlantic species of *Avocettina, A. infans* Günther of presumably cosmopolitan distribution and *A. exophthalma* Parr from the West Indies; in addition, at least one undescribed species is probably included among the examples of this genus already recorded from the Atlantic. The third known Atlantic species, *A. elongata* (Gill and Ryder), is synonymous with *A. infans. A. bowersii* Garman, from the eastern Pacific, is valid, as is probably *A. gilli* (Bean) from Alaska. The final decision concerning the latter species, however, must await a redefinition of *A. infans.*

3. The development of *Nemichthys* is traced through a consecutive series of stages, proving that the form "Leptocephalus B," considered by Roule and Bertin (1929) to be a giant albino or variable larva of *Nemichthys scolopaceus,* belongs to a different species and probably a different genus; the same is true of some of the older larvae described in their report.

4. The specimens recorded by Borodin (1931, pp. 73-74) as *Tilurella Nemichthydis infantis, Nemichthys infans* and *Serrivomer sector* are all

[1] Contribution No. 547, Department of Tropical Research, New York Zoological Society. Contribution, Bermuda Biological Station for Research, Inc.

post-larval and adolescent specimens of *Nemichthys scolopaceus*. *Nemichthys* sp., described in the same place, is a transitional adolescent *S. beanii.*

Structure: 1. The teeth of *Nemichthys* are set in curving bands, rather than in the quincunx formation typical of *Avocettina* and *Labichthys.*

2. The skeleton of *Labichthys* is less specialized than those of the other genera.

3. Coelomic organs are unpigmented in *Avocettina.*

4. Although *Labichthys* and *Avocettina* are more closely related to each other than to *Nemichthys, Nematoprora* and *Cercomitus,* yet these genera have far more osteological similarities than differences when compared with their near neighbors, the Serrivomeridae and Cyemidae. Hence they are included in a single family, the Nemichthyidae.

Ecology: 1. Next to *Serrivomer beanii* and *Eurypharynx pelecanoides, Nemichthys scolopaceus* is the most common deep-sea eel found in our Bermuda trawling area, 45 specimens having been taken in the nets. *Labichthys,* on the other hand, is represented by only three specimens and *Avocettina* by one.

2. Young, six-inch nemichthyid eels (provisionally identified as *Labichthys*) were recognized from the bathysphere at a depth of only 75 fathoms, far above the level at which specimens of this size have been taken in the nets (500 to 1,000 fathoms).

FAMILY NEMICHTHYIDAE.

Characteristics: Naked deep-sea eels with the body extremely slender and jaws excessively attenuated; snout much more than half length of head; teeth small with backwardly directed, curving tips, numerous, set in curving bands or quincunxial rows; two pairs of large nostrils, the anterior with short tube, close in front of eye; nuchal constriction present; gill openings well developed, convergent forward; anus far in advance of middle of length; pectorals and vertical fins well developed; fin membranes thin, not enveloping rays; lateral line pores present or absent; caudal filament present or absent.

Skeleton moderately well developed; frontals united anteriorly; parietals separate or united; supraoccipital present or absent; pterotic large with sensory canal tube extending forward to overlap frontals; palatine absent; pterygoid much reduced or absent; hyomandibular and quadrate forming with the mandible an angle of slightly more than 90 degrees; anterior end of frontal intercalated with the divided posterior end of ethmo-vomer, the two prongs of which join or almost join above the frontal; mandible shorter than ethmo-vomer; maxillary very short, articulating with the excessively elongate ethmo-vomer near its base; opercular apparatus reduced and little ossified, the opercle alone being constantly present; preopercle always absent; hyoid and branchial apparati both reduced and feebly ossified, the pharygobranchials being strongest; branchiostegal rays 7 to 10; supracleithrum absent; cleithrum, coracoids and radials feebly or moderately ossified; vertical fins feebly supported, not well ossified; vertebrae numerous, increasing with age, 170 to more than 500.

Coelom relatively small; intestine curved forward on its own length; a single small caecum; stomach a blind sac; liver small, elongate; kidney extremely elongate; gonads dorsal, extending farther posteriorly than all other organs except kidney.

Affinities: As already pointed out in our discussion of the Serrivomeridae (*Zoologica,* Vol. XXII, No. 26, p. 346), the nemichthyids are in most respects more highly specialized than the serrivomerids, as is shown by

their extremely elongated jaws, attenuated bodies, more anteriorly placed anus, reduced or vestigial palato-pterygoid, opercular, hyoid and branchial apparatus, and more numerous vertebrae. Their teeth and comparatively strong pectorals, however, are characters less highly differentiated than in the serrivomerids.

In the Cyemidae the opercular and branchial apparatus is even more reduced than in the nemichthyids, although the jaws are similar. The excessive reduction of its vertebrae in a group noted for a high vertebral count leads to interesting speculations on ancestral forms.

Because of the close osteological relationships of *Nemichthys* and *Nematoprora* with *Avocettina* and *Labichthys* these four genera are at present, with *Cercomitus*, considered to form a single family (see below).

Taxonomic Discussion: Five genera have been described, *Nemichthys* Richardson (1848), *Labichthys* Gill and Ryder (1883), *Avocettina* Jordan and Davis (1888), *Nematoprora* Gilbert (1905) and *Cercomitus* Weber (1913). *Nemichthys* and *Avocettina* are of cosmopolitan distribution, *Labichthys* is known only from the Atlantic, and *Nematoprora* and *Cercomitus* have been taken only in the Pacific, although evidence is accumulating to show that one or both of these genera also occur in the Atlantic (see p. 361). The first three genera are all represented in the collections taken on the Bermuda Oceanographic Expeditions.

Key to the Genera.

A. Lateral line with pores.

B. Three rows of tiny pores; caudal filament present; vertebrae not fewer than 300, usually many more.................................. *Nemichthys*

BB. A single row of large pores; caudal filament absent; vertebrae not more than 200.

C. Anal origin scarcely behind level of pectoral base..... *Labichthys*

CC. Anal origin well behind level of pectoral base, the postorbital distance being contained more than one and three-quarters times the distance between pectoral base and anal origin. .... *Avocettina*

AA. Lateral line without pores.

D. Gill slits narrow; backwardly directed points on teeth well developed, conspicuous.. *Cercomitus*

DD. Gill slits wide, points on teeth small, inconspicuous..... *Nematoprora*

Genus **Nemichthys** Richardson, 1848.

Generic Characters: Nemichthyids with three rows of minute pores in the lateral line; caudal filament present; ethmo-vomerine teeth in eight longitudinal rows set in curving, transverse bands; anus and anal origin scarcely behind level of pectoral base; dorsal origin on occiput, in advance of level of pectoral base; dorsal rays in middle third of body short, spinous.

Parietals separated by suture; supraoccipital absent; pterygoid absent; mandible slightly shorter than ethmo-vomer; preopercle, subopercle and interopercle absent; glossohyal, basihyal and hypohyals absent; ceratohyal feebly ossified with eight strongly curved branchiostegals; branchial apparatus completely cartilaginous except for faintly ossified pharyngobranchials; basibranchials apparently absent; coracoid and four radials ankylosed, feebly ossified; cleithrum at level of fifth vertebra; vertebrae 300 (in young specimens) to 660.

Leptocephalus characterized by an elongate body, long snout (but not of characteristic *Nemichthys* attenuation), posteriorly placed anus, many myomeres and characteristic pigmentation (see pp. 357 ff.)

Discussion: In their monograph on the nemichthyid eels published in 1929, Roule and Bertin decided that, in spite of the tremendous differences in proportions and differences of range, all of the recorded specimens of *Nemichthys* belonged to a single species, *Nemichthys scolopaceus*, first described by Richardson in 1848. The extensive *Dana* collections, they reasoned, provided ample material for the study of variation, and they found, through numerous measurements, that the variations of each character gave a normal curve with a single, median node, and that specimens of various types were not confined to one geographical area: for example, specimens with very large eyes were taken in the same region with small- and medium-eyed examples.

Our careful examination of their evidence can find no flaw in their reasoning: the liability of both the jaws and caudal filament to injury leaves very few characters which can be accurately measured, the best of these being the relation of the diameter of the eye to the postorbital length of the head. Nevertheless, especially in the light of the presence of at least two forms of *Nemichthys*-like larvae (see pp. 357 ff.), it seems inevitable that two or more species are included in the *Dana* collection, and that at least one or two of the other species of *Nemichthys* synonymized by Roule and Bertin with *N. scolopaceus* will, in the light of future material, prove to be valid.

It may be stated here that *Nemichthys fronto*[2] Garman, 1899, from the west coast of central America appears to be perfectly valid: every single one of the *Dana* specimens from the Gulf of Panama (Roule and Bertin, 1929, Tables III and IV, pp. 14-15 and 17-18) have the small eyes (or large postorbital distances) characteristic of that species, the diameter being contained in the postorbital length of the head 3.6 to 5.3 times. Small-eyed specimens were, however, taken in the Atlantic as well.

The extremes of proportions, which include those of other authors as well within the *Dana* material, are as follows: Maximum height of trunk in length 39 to 200; head in length 9 to 21 times; caudal filament 2.3 to 6.3 times in length; length of snout in head 1.3 to 1.8; eye diameter in head length 7.4 to 18.2; eye diameter in snout length 4.5 to 13; diameter of eye in postorbital length 1.4 to 5.3; pectoral length in postorbital length 0.5 to 3.5.

It will be seen that all of these proportions far exceed normal ranges of specific variation. At present, nevertheless, we can only agree with Roule and Bertin—except that we maintain the validity of *N. fronto*—and refer the known specimens of the genus to *N. scolopaceus*.

The following species referable to *Nemichthys* have been described: *Nemichthys scolopaceus* Richardson (1848), *Leptorhynchus leuchtenbergi* Lowe (1852), *Belonopsis leuchtenbergi* Brandt (1854), *Nemichthys acanthonotus* Alcock (1892), *Nemichthys fronto* Garman (1899), *Nemichthys mediterraneus* Ariola (1904), *Leptocephalus canaricus* Lea (1913), *Leptocephalus andreae* Schmidt (1912) and *Tilurella gaussiana* Pappenheim (1914). *Nemichthys avocetta* Jordan and Gilbert (1880), since it apparently lacks a lateral line, probably belongs to another genus.

In addition to type descriptions, the chief references to this relatively well known genus of deep-sea eels are the following. *Nemichthys scolopaceus*: Günther (1887), Vaillant (1888), Goode and Bean (1895), Jordan

[2] We have examined the type specimen, deposited in the Museum of Comparative Zoology, and found the original description to be accurate.

and Evermann (1896), Brauer (1906), Roule and Bertin (1929), Norman (1930) and Borodin (1931)[3].

Nemichthys has previously been taken from the western Atlantic by the *Blake* (Goode and Bean, 1895), by fishermen (Mowbray, 1922), by the *Dana* (Roule and Bertin, 1929) and by the *Atlantis* (Borodin, 1931).

In the following pages a description is given of the largest (transitional adolescent) Bermuda specimens as well as of a series of growth stages taken in the same locality.

Nemichthys scolopaceus Richardson, 1848.

SPECIMENS TAKEN BY THE BERMUDA OCEANOGRAPHIC EXPEDITIONS.

45 specimens; April to September, 1929 to 1931; 50 to 1,000 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.; standard lengths from 40 to 357 mm.

SPECIMENS PREVIOUSLY RECORDED.

About 110 adult and almost adult specimens in addition to about 675 larvae and young; surface to 3,281 fathoms; North Atlantic, Mediterranean, Indian Ocean and East Indies from the equator to about 40° N.; lengths from 9 to 1,445 mm.

DESCRIPTION OF TRANSITIONAL ADOLESCENT.

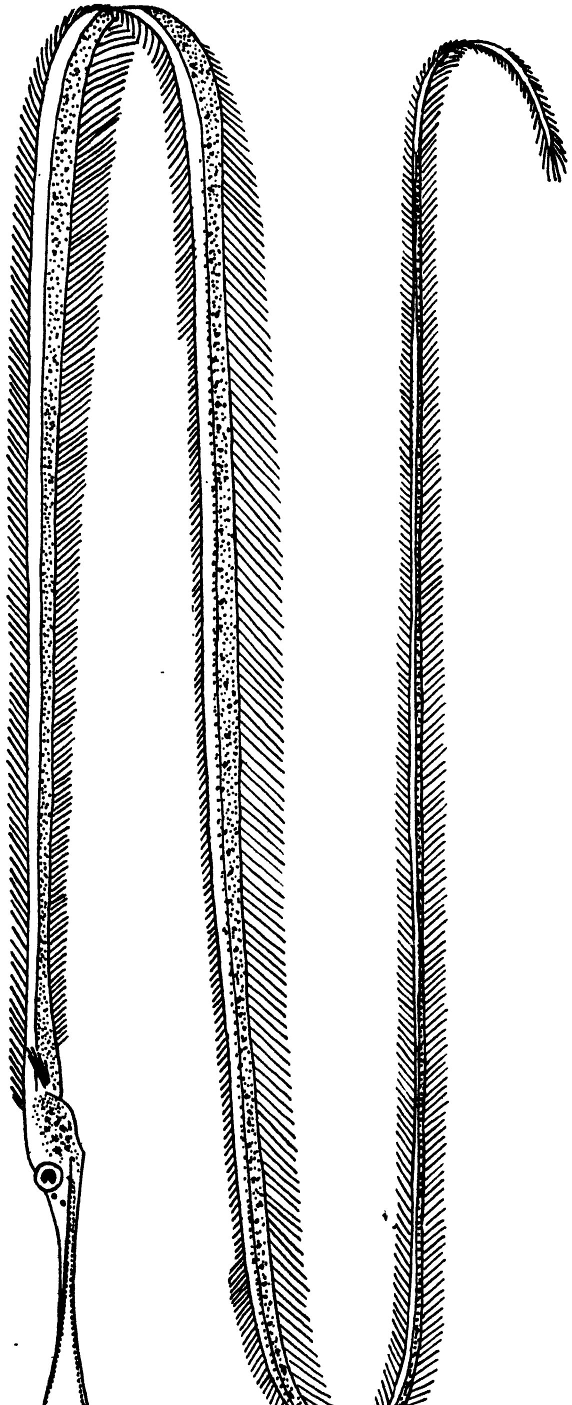
(Text-figs. 1, 2, 3C, 4G, 5G).

The following measurements and observations are taken from the three largest specimens in the Bermuda collection. All three have snout tips and caudal filaments complete and measure, respectively, 342, 342 and 357 mm. without caudal fin. The small amount of variation in the proportions, compared with the large amount in the series described by Roule and Bertin (1929) is notable. It will also be seen that the proportions do not differ markedly from those of the type, when allowance has been made both for the difference in age and for the possible damage to the snout tip in the type; the most reliable proportion, that of the eye in the postorbital distance, is seen to be very close in the two cases: 2.2 in the type, 2.4 to 2.9 in the present specimens, when these figures are compared with the great range of 1.4 to 5.3 in the series described by Roule and Bertin.

Color: (Fresh specimens). Pale tan to light brown (most advanced specimen), the ventral two-thirds of the body marked by dendritic chromatophores which are largest and densest on the abdomen. There are a few similar pigment spots on the proximal parts of the jaws and on the crown of the head, while the caudal filament is very sparsely pigmented, and that only on the ventral surface.

Proportions: Maximum depth (in advance of middle of body) in length 118 to 132 (.76 % to .85 %); depth of caudal filament at caudal base in eye diameted 6.9 to 8.1 (.0008 % to .0009 % of length); head in length 12.3 to 12.8 (7.8 % to 8.1 %); eye in head 12.2 to 13.2, in snout 8.4 to 9.3, in postorbital 2.4 to 2.9 (.62 % to .64 % of length); snout in head 1.4 to

[3] Specimens recorded (1931, pp. 73-74) as *Nemichthys infans, Tilurella Nemichthydis infantis* and *Serrivomer sector* examined by us in Museum of Comparative Zoology and found to be postlarval and adolescent *Nemichthys scolopaceus*, identifiable by their myomeral counts, pigmentation and rudimentary, but distinct, caudal filaments. The specimen described as *Nemichthys* sp. is a transitional adolescent *Serrivomer beanii*, identifiable by means of the teeth and the anterior prolongation of the branchiostegal rays.



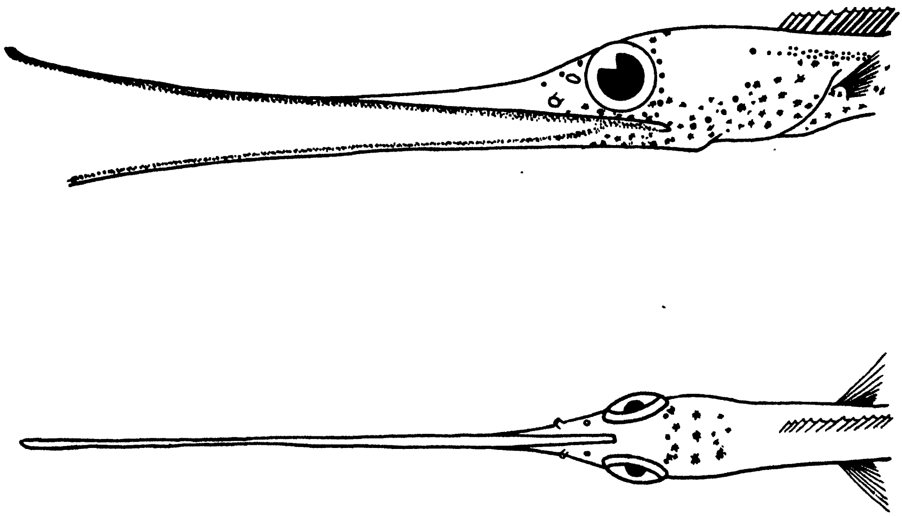
Text-figure 1.
Nemichthys scolopaceus. Standard length 342 mm. The complete numbers of fin rays are not indicated.

1.45 (5.4 % to 5.7 % of length); postorbital in head 4.6 to 5.2, in snout 3.2 to 3.7, (1.5 % to 1.8 % of length); interorbital in head 26.4 to 27, in eye 2 to 2.2, (.31 % to .34 % of length); maxillary extending slightly beyond posterior margin of orbit; tip of snout to tip of mandible in length of snout 15.4 to 17.1 (.33 % to .34 % of length; pectoral base to anal origin in postorbital length of head 1.6 to 1.8, (.94 % to .96 % of length); pectoral length in postorbital length 1.9 to 2.1; caudal filament in length 3.1 to 3.3 (30.4 % to 33 %).

Teeth: (Text-figs. 3C, 6, 7, 8). The maxillary holds a maximum of four rows of teeth irregularly arranged. On the ethmo-vomer there are, in the broadest portion, eight longitudinal rows set, not in quincunx, but in curving, transverse bands, the number of teeth in a longitudinal series being about 160. A secondary pattern formed by the same teeth is a sequence of V's, each apex being directed posteriorly. There is no trace, however, of a true quincunxial formation, such as has been described by previous authors reporting on *Nemichthys* and found by us in both *Avocettina* and *Labichthys*. On each mandibular ramus there are six longitudinal rows of teeth arranged in a strongly oblique series of transverse rows directed forwards and inwards, so that when the two rami are approximated a V-shaped pattern is formed like that of the ethmo-vomer; the curving, transverse bands characteristic of the latter bone, however, are not evident, although here also, the obliqueness of the transverse rows throws the teeth far out of quincunxial arrangement. Because, perhaps, of the youth of the specimens, the teeth are relatively shorter and blunter than in either *Avocettina* or *Labichthys*, while the terminal swellings of both jaws, although distinctly present, are not as well developed as in the other genera.

Fins: Pectoral rays 11, their length contained 1.9 to 2.1 times in post-orbital length, the first ray more strongly developed than the others, inserted at or slightly in front of the upper angle of the branchial cleft, below the second to sixth dorsal ray[4]. Dorsal rays about 405 to 450, about 100 of the median ones (from the 118th-148th ray to the 220th-252nd ray) being

[4] Instead of below the eleventh or twelfth dorsal ray, because of the immaturity of the specimens; as has been said, in larger specimens the dorsal originates even farther forward on the occiput.

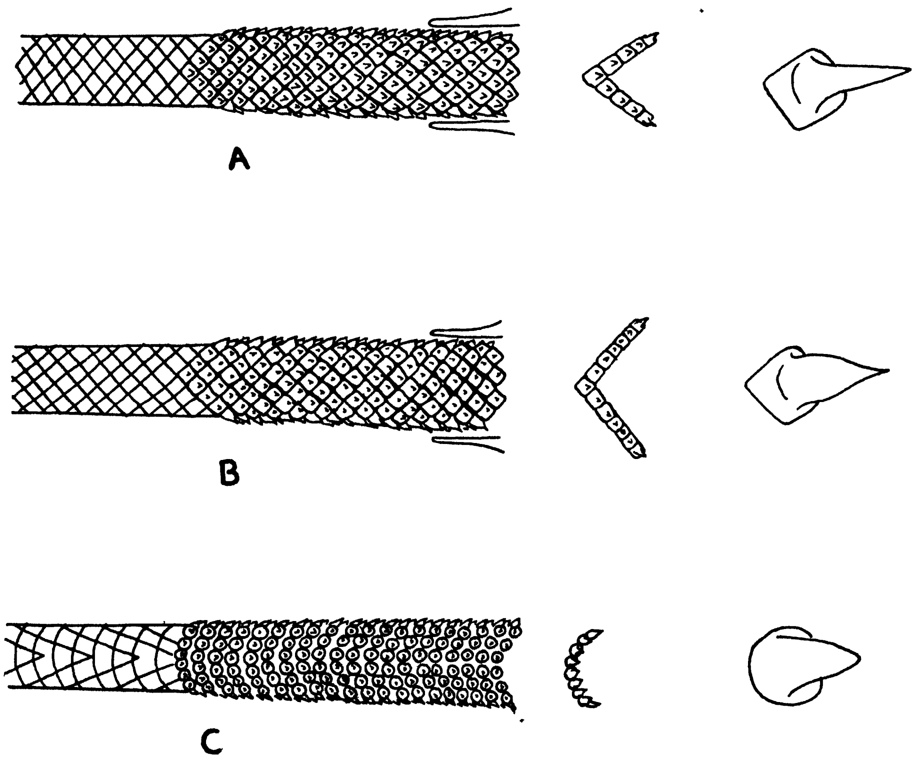


Text-figure 2.
Nemichthys scolopaceus. Head, lateral (upper) and dorsal (lower) views. Standard length 342 mm. (x 4.1).

reduced to spines by the breaking off of the delicate terminal portions of the rays; the last "spine" occurs about 15 rays in front of the origin of the caudal filament. Anal rays about 415 to 454, the longest in middle third of body, more than three times longer than dorsal rays and 25 % longer than maximum body depth; on the caudal filament both dorsal and anal rays are much shorter and more widely spaced than elsewhere, but along the entire length of the filament the rays, when unbroken, are 1.5 to 2 times the depth of the body at the corresponding point; in this caudal region, the anal rays are only slightly longer than the dorsal. Caudal rays five.

Vertebrae and Pores: There are about 450 vertebrae in a cleared and stained specimen 342 mm. in length, about 145 to 150 of them being included in the caudal filament. The characteristic pores, arranged quincunxially in three rows, are invisible in specimens examined in or out of the alcohol in which they have been preserved. After they have been soaked for half an hour or more in fresh water, however, the presence and pattern of the pores are clearly discernible under moderate magnification in at least the anterior part of the body; posteriorly they are so rudimentary that their numbers cannot be counted accurately.

Osteology: (Text-figs. 5-9). With the characteristics of the genus,



Text-figure 3.

Semi-diagrammatic representations of vomerine teeth in nemichthyid eels at broadest part of bone (near articulation with maxillary). The median vertical series represents single bands of teeth from the same sections of the vomer. Right-hand series shows single teeth, greatly enlarged. **A**, *Labichthys carinatus*, standard length 470 mm.; **B**, *Avocettina* sp., standard length 498 mm.; **C**, *Nemichthys scolopaceus*, standard length 357 mm.

which were derived from the cleared and stained 342 mm. specimen, one of the transitional adolescents under discussion. Immaturity is shown in the excessively slight degree of ossification, which is slight even for this delicately ossified family. The jaws alone show a moderate amount of stain, while the skull, opercular, hyoid and branchial apparatus show only a slight amount of bony matter and all the fins, their supports and the vertebral column are entirely unossified. Another indication of immaturity lies in the shape of the vertebrae, which are almost cylindrical. The simplicity of the tail, however (Text-fig. 9) is probably generic rather than juvenile.

DEVELOPMENT.

(Text-figs. 4, 5).

Material: All stages, with the exception of the adult, are represented in the collection:

Larvae, 38 to 210 mm.: 10 specimens.

Post-larvae, 200 to 295 mm.: 13 specimens.

Adolescents, 240 to 312 mm.: 17 specimens.

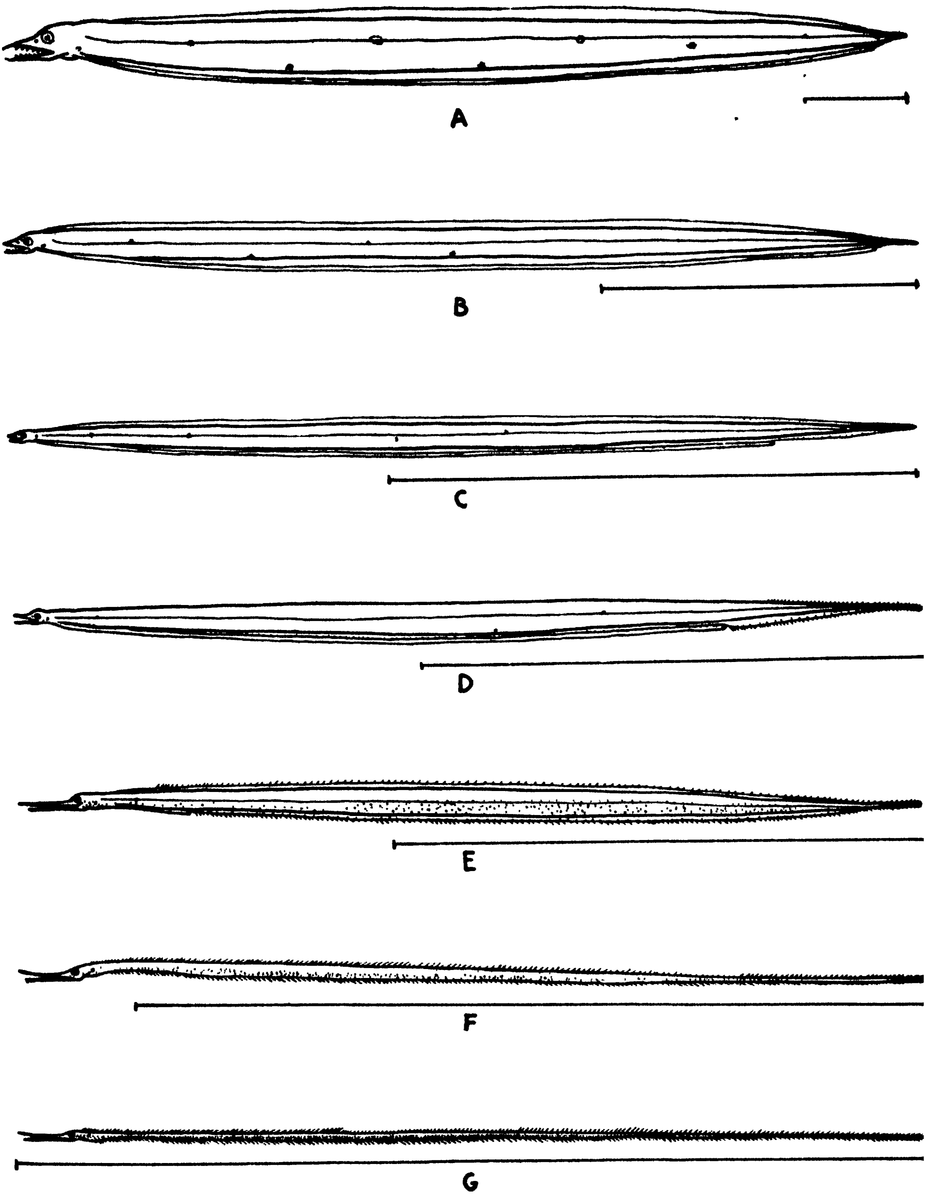
Transitional adolescents, 300 to 360 mm.: 5 specimens.

Key to the Growth Stages: The following key will serve to distinguish the various growth stages, and to correlate them with the series described by Roule and Bertin (1929, pp. 67-96).

A. Body flattened laterally, its height much greater than its thickness and contained not more than 75 times in the length; translucent.
- B. Depth in length 10-35; anal fin not in final position.
  - C. Larval fangs present; anal origin between 93rd and 257th myomeres, near end of body; no caudal filament. .... *Larva* ("Leptocephale A").
  - CC. Larval fangs absent; anal origin between 256th and 7th myomeres, moving forward on body; caudal filament appearing. .... *Post-larva* ("Tilurelle A," *partim.* and "Tilurelle B," *partim.*).
- BB. Depth in length 60-75; anal fin in final position (at about 6th myomere) .... *Adolescent* ("Jeunes *Nemichthys* transparents," *partim.*).

AA. Body rounded; slender (depth contained at least 120 times in the length; opaque.
- D. Gonads developing; pigmentation, position of dorsal fins, ossification and dentition immature in earlier half of stage. .... *Transitional Adolescent.*
- E. Gonads mature.......... *Adult.*

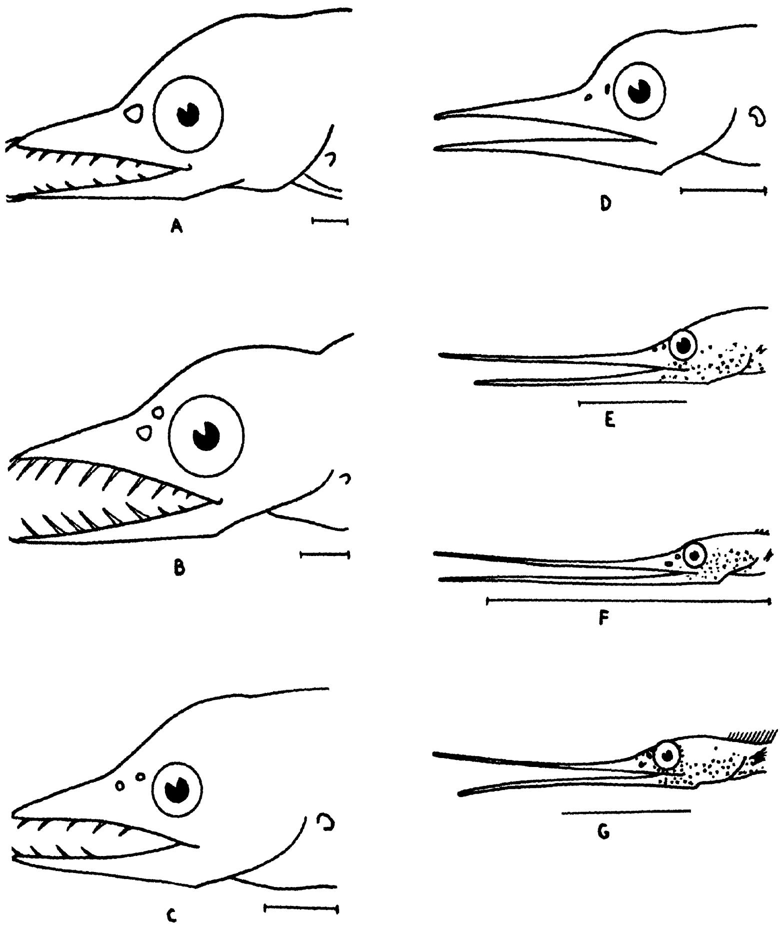
General Discussion: In 1929 Roule and Bertin (pp. 61 ff.) identified the larva of *Nemichthys* as a leptocephalus characterized chiefly by the presence of a great number of myomeres, posteriorly placed anus, mesenteric ligaments located in the same myomeres as in transformed specimens, long snout, and larval pigment spots on the medullary chord, along the intestine, and, post-anally, along the bases of the dorsal and anal fin. This general type they found to contain two forms; the first, designated as "Leptocephalus A," was characterized by the presence of four external, lateral pigment spots which always occurred at or near the 19th, 38th, 79th and 116th myomeres, by its smaller size range, and by the relatively small number of preanal myomeres. The second, designated as "Leptocephalus B," lacked all trace of the four lateral pigment spots, grew much larger before metamorphosing, and had a correspondingly large number of preanal myomeres.



Text-figure 4.

Nemichthys scolopaceus. **A** to **C**, incl., larvae, 40, 125 and 210 mm., respectively; **D** and **E**, post-larvae, 200 and 210 mm.; **F**, adolescent, 312 mm.; **G**, transitional adolescent, 357 mm.

It probably represented, Roule and Bertin decided, either another race of *Nemichthys scolopaceus* or a giant albino form of the same species, their identification resting largely on the positions of the mesenteric ligaments, the last one in each case being oblique and lying between the 83rd and 94th myomeres.



Text-figure 5.

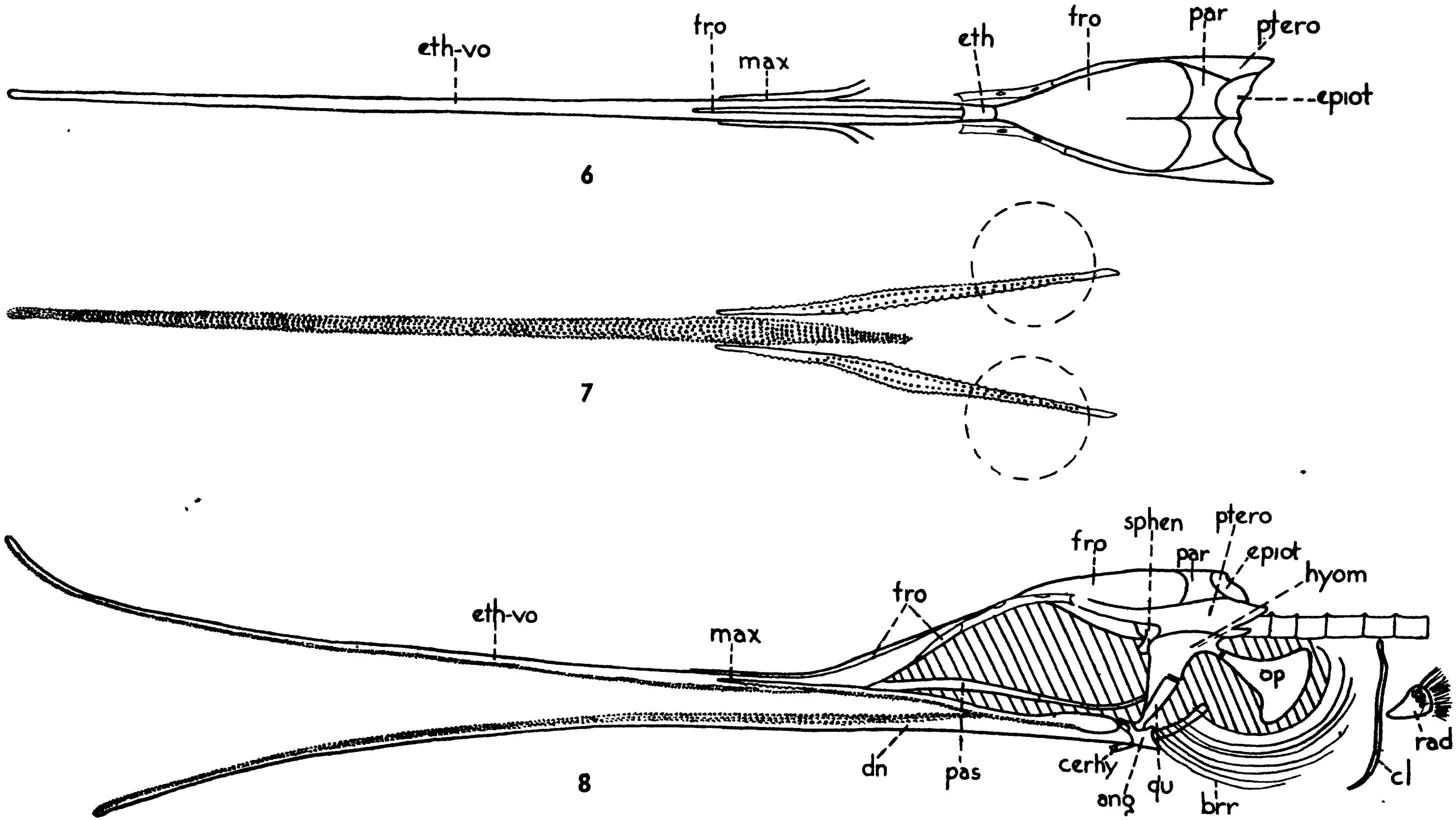
Nemichthys scolopaceus. A to C, incl., larvae, 40, 125 and 210 mm., respectively, in standard length; D and E, post-larvae, 200 and 210 mm.; F, adolescent, 312 mm.; G, transitional adolescent, 357 mm.

They further described six postlarvae ("Tilurelle A" and "Tilurelle B"), and three adolescents ("jeunes *Nemichthys* transparents") which show discrepancies both of size and coloration in the formation of the single series urged by these authors. All of these differences, however, they contend must be due to the variability of the species, and to the lack of sufficient material in the transforming, intermediate stages.

The following table will make these discrepancies clear:

Leptocephalus A, 664 specimens, length 9 to 253 mm., preanal myomeres 93 to 254.

Leptocephalus B, 26 specimens, length 32 to 359 mm., preanal myomeres 179 to 320.



Text-figures 6-8.

Nemichthys scolopaceus. **6.** Skull of transitional adolescent, dorsal view; standard length 342 mm. (x 7.1). **7.** Same, teeth of upper jaw and vomer, ventral view. (x 7.1). **8.** Same, bones of head, pectoral girdle and anterior part of vertebral column, lateral view. (x 7.1).

Tilurella A, 6 specimens, length 224 to 374 mm.; preanal myomeres 180 to 297.

Tilurella B, 4 specimens, length 230 to 286 mm.; preanal myomeres 70 to 39.

Young *Nemichthys*, transparent, 2 specimens, length 393, 413 mm.; preanal myomeres 6.

It will be seen that in Leptocephalus A the full range of preanal myomeres is from 93 to 257. The range for larger larvae (loc. cit., Table XV, p. 76), in which the anus has reached its most posterior position, is between 228 and 257 pre-anal myomeres; this stage being reached at 46 mm. In Leptocephalus B, on the other hand (loc. cit., Table XVI, p. 82), the full range is from 179 to 320 myomeres, the range for larger larvae being between 312 and 320 pre-anal myomeres, while this stage is not reached until 174 mm., the increase in pre-anal myomeres continuing until that point. Furthermore, the numbers in specimens of the same size—always one of the most important characters in the identification of larval eels—do not correspond in the two forms except in the smallest specimens: for example, the largest Leptocephalus A, at 253 mm., has 248 pre-anal myomeres, while two Leptocephalus B, of the corresponding lengths 231 mm. and 262 mm., have respectively 312 and 318 pre-anal myomeres.

Taking into account the minute specific differences between closely related leptocephali (e. g., between the larvae of *Anguilla anguilla* and of *Anguilla rostrata*) it seems clear that the differences between Leptocephali A and B of Roule and Bertin indicate that two entirely different species are involved, instead of merely two races, or normal and abnormal specimens. There seems no reason to suppose that either the general facies, the location of the last *bride mesentrique*, stressed by Roule and Bertin as constant in the two forms, or the fact that both "A" and "B" were often taken in the same net, prove that the forms are varieties of the same species; instead it seems much more probable that the form and position of the ligaments are family, or possibly, generic, characters.

The Tilurella A, ranging from 224 to 374 mm., also show discrepancies. The smallest is all of 135 mm. shorter than the largest larva of the Leptocephalus B type, while the following stage, Tilurella B, is represented by three specimens, all very short (230 to 286 mm.) compared with the longest Leptocephalus A and Tilurella A. Finally, the youngest adolescent specimens ("young transparent *Nemichthys*") mentioned, represent the earliest stage at which the dorsal and anal have reached their final positions and are, as the authors say, much farther advanced than the preceding stage, measuring 393 and 413 mm.—a length gap of more than 100 mm.

From a detailed study of the Bermuda material, we may confidently draw the following conclusions:

1. The careful description by Roule and Bertin of Leptocephalus A is perfectly applicable to our larvae, which make a continuous series, without either gaps or extensive overlappings in length, through post-larvae and adolescents to transitional adolescents of *Nemichthys*, presumably *N. scolopaceus*.

2. Roule and Bertin's Leptocephalus B belong to some other *Nemichthys*-like form, either *Cercomitus* or *Nematoprora*, or else to another species of *Nemichthys*, which is probably contained in the *Dana* collection—either the large-eyed or very small-eyed Atlantic form.

3. Their Tilurella A probably contains forms of both our species of *Nemichthys* (especially the smallest, in which Roule and Bertin were able to distinguish remains of the characteristic lateral chromatophores of Leptocephalus A, of which one or more of the possible four were distinguishable in every one of our post-larvae) and of the Leptocephalus B form, whatever that proves to be.

4. Doubtless some of the succeeding immature forms also belong to another species, either *Nemichthys* or a related genus, because of the following observations: Their smallest "adult" (i.e. transitional adolescent) measures only 215 mm. in length, while most of the deep-sea eels whose growth stages are known undergo the final steps of mètamorphosis at about the same length within the species (*Serrivomer, Platuronides, Derichthys, Nessorhamphus*). In the second place, on p. 13 these authors state that the pigment of young *Nemichthys* develops tardily and, as in *Cercomitus* (Weber) appears first near the end of the caudal filament and in the region of the kidney; three of these forms they have figured on Pl. I, figs. 7, 8 and 9. They mention there are a few abnormal forms in which the pigment appears as "large black spots generally distributed on the ventral half of the body, as in their Pl. I, g. 10. Owing to the presence on three post-larvae in the present Bermuda collection of both typical larval lateral chromatophores and of the beginnings of general pigmentation in the form of superfical chromatophores on the ventral half of the body, it is certain that the "abnormal" specimen figured by them is in reality a true *Nemichthys* which has developed from a Leptocephalus A, since in adolescent specimens only slightly older, and with this same characteristic pigmentation, we have discovered the typical series of *Nemichthys* pores which Roule and Bertin found to appear only very tardily. The pores are, however, exceedingly difficult to see in these young specimens and not all of them are developed at this stage; sometimes they are distinguishable only after the alcoholic specimen has been soaked for an hour or two in fresh water; a moderately strong lens is, of course, necessary.

5. The following synonymy of *Nemichthys* leptocephali and immature forms may now be made:

Nemichthys scolopaceus:

- *Leptocephalus andreae* Schmidt, 1912.
- *Leptocephalus canaricus* Lea, 1913.
- *Tilurella nemichthydis scolopacei* Roule, 1914, 1919.
- *Tilurella gaussiana* Pappenheim, 1914.
- *Nemichthys scolopaceus,* Leptocephalus A, Roule and Bertin, 1929.
- *Nemichthys scolopaceus,* Tilurella A, Roule and Bertin, 1929 (*partim*).
- *Nemichthys scolopaceus,* Tilurella B, Roule and Bertin, 1929 (*partim*).
- *Nemichthys scolopaceus,* young transparent *Nemichthys,* Roule and Bertin, 1929 (*partim*).
- *Nemichthys infans,* Borodin, 1931.
- *Tilurella Nemichthydis infantis,* Borodin, 1931.
- *Serrivomer sector,* Borodin, 1931.

Diagnostic Description of the Growth Stages: The characteristics of the growth stages are summarized below. For a thorough description of the larva, consult Roule and Bertin's description of Leptocephalus A (1929, pp. 68-81). For a description of the internal organs of subsequent stages, see the same source, pp. 86, 89.

Larva: (Text-figs. 4 A-C, 5 A-C). Pigment: This is found in four groups of chromatophores, the first two tending to disappear in older larvae, the last two becoming more nóticeable with age: 1. A conspicuous chromatophore situated between the lateral mid-line and the ventral profile at or about the 19th, 38th, 79th and 116th myomeres. Of these, the first usually placed almost in the lateral mid-line, is the most constant; it has been found even in advanced post-larvae. 2. A series of internal spots on the spinal chord, which become more numerous with age; in small specimens there are usually three conspicuous ones, visible externally, through the skin,

in or near the 55th, 92nd and 145th myomeres. 3. A series of minute chromatophores on the dorsal surface of the intestine; in young specimens these are present on the posterior portion only, becoming more numerous and more extensive anteriorly with age. 4. A series of minute chromatophores on the dorsal and anal finfolds at the base of the developing dorsal and anal rays. These, too, increase in number with the development of the fins. In the very youngest larvae in the collection they are represented by less than half a dozen conspicuous spots posterior to the anus above and below the lateral mid-line.

Proportions: Depth (measured to exclude intestines and finfolds) 9 to 25 in length (11 % to 4 %). Head in length 8 to 40 (12.5 % to 2.5 %), largest in youngest specimens. Eye 4 to 5 in head, decreasing in size relative to the trunk with growth, almost round even in young specimens. Snout long, slender, longer than postorbital distance measured from posterior margin of eye to base of pectoral fin; profile of snout very broadly V-shaped, owing to a depression at level of nostrils; depth of head relative to its length almost constant throughout larval stage; supraorbital distance moderately great—not excessive as in serrivomerid larvae; highest point of head above posterior part of eye or just behind it; tips of jaws equal, or upper projecting very slightly; jaw angle under middle of eye in oldest specimens; this change in position is due partly to the relative decrease in the size of the eye and partly to an actual prolongation of the jaw.

Teeth: One or two pairs of long, slightly curved, fang-like larval teeth at tips of both jaws, each tooth being followed by four to nine similar ones, usually longer than the terminal fangs. The teeth are relatively longest in half-grown larvae (around 125 mm. in length); in fish of this length the teeth are all about of equal size (more than one-third longer than eye diameter), except for the first fangs and the last two pairs, which usually are somewhat smaller. As in other leptocephali, the larval teeth drop out gradually as the time for metamorphosis approaches, at a length of around 210 mm., until, in post-larvae, when the migration of the anal commences, they are completely lacking.

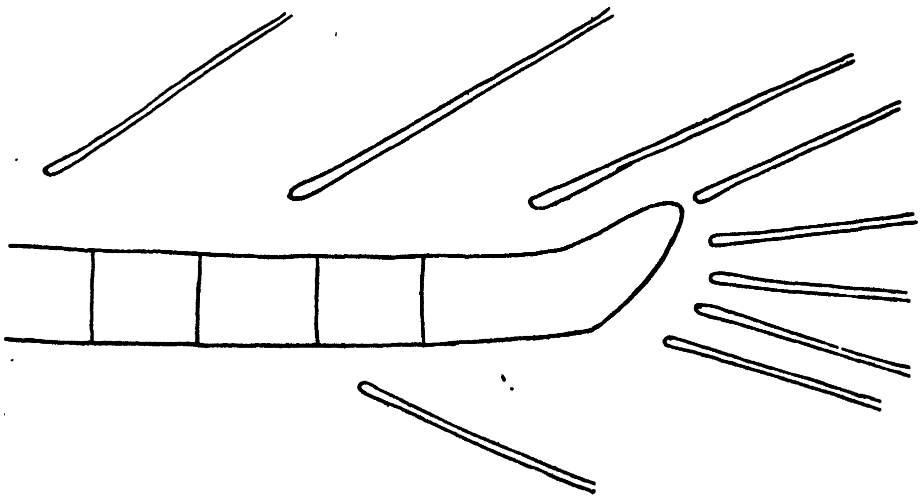
Fins: Pectoral small, fan-like, without true rays, typically larval; anal very short, occupying in young larvae the last one-twentieth of fish, in grown larvae, one-sixth (because of the increase in caudal myomeres alone, since the forward migration of the anus has not yet begun). Dorsal fins about equal in length to anal, sometimes extending slightly farther forward; rays of both fins only rudimentary in even the largest larvae. Dorsal and anal finfolds extending throughout length of body behind the nape, and behind the heart below the intestine, respectively. Caudal rays invisible in larvae, the finfolds dying out just before the very slender, pointed tip of the posterior end of the body.

Myomeral Count and Length Range: In the larva there is a total of about 100 to 450 myomeres, of which about 93 to 254 lie in front of the anus; the typical pre-anal count of about 230 to 254 is reached at about a length of around 65 mm. As has been said, the post-anal myomeres continue to increase throughout development. Roule and Bertin (loc. cit.) show that the extreme length range of the larva (Leptocephalus A) is from 9 to 253 mm.; our small series of 10 specimens range from 38 to 210 mm.

Post-larvae: (Text-figs. 4 D-E, 5 D-E). Examples of this stage in the present collection measure from 200 to 295 mm. As in other eels, during the post-larval and adolescent stages, the actual transformation from leptocephalus to anguilliform takes place. The post-larva differs from the larva most obviously in the loss of larval teeth, the gradual elongation and slenderizing of the snout, in the continued reduction of the relative size of the eye, and in the forward migration of the vertical fins, with a corresponding shortening and, later, the bending of the intestine. The individual finrays, though very short, become distinctly visible in this stage, the dorsal and

anal being still suspended above and below the body proper by finfolds, although the intestine is more closely approximated to the body than in the larva. In relative depth there is little change, although a slight increase in thickness takes place. The internal medullary and the intestinal pigment spots increase in number, while most of the external lateral characteristic pigment spots, near the 19th, 38th, 79th and 116 myomeres, are often lacking, although at least one, usually the first, remains in even the most advanced specimens. In these oldest post-larvae there are present, in addition to the larval spots, dendritic, adult chromatophores on the ventral half of the body. They extend from the postorbital region back as far as about the beginning of the last seventh of the body; the last seventh lacks all trace of pigment, proving that the *Dana* specimens in which pigment developed first in this position must have belonged to another species (see p. 361).

Adolescent: (Text-figs. 4 F, 5 F). Examples of this stage in the present collection range from 240 to 312 mm. The adolescent differs from the post-larva primarily in the fact that the anus, and with it the anal fin, has reached its final position immediately behind the base of the pectoral fin. It differs from the adolescent stage of other fishes in that the dorsal fin is not similarly completed: while it has already reached a position well in front of the pectoral, it continues to migrate slowly forward throughout not only adolescence, but transitional adolescence as well, until it reaches its characteristic position far forward on the occiput. The form of this adolescent stage is somewhat semi-leptocephalid (depth in length about 60 to 75, or 1.65 % to 1.34 %), although the fins are scarcely suspended above and below the profiles any more, and the body has thickened slightly. The depth is about half that found in post-larvae and twice that of transitional adolescents. The snout and jaw are typically nemichthyidiform, while the eye and postorbital distance are reduced to about their final relative small size in respect to the length of the head. The teeth are rudimentary. The caudal filament is distinguishable, though it is not as well marked as in the succeeding stage. The characteristic short, spinous finrays of the median part of the dorsal are not yet distinguishable. When the adolescents are soaked in water, typical series of *Nemichthys* pores become visible in the



Text-figure 9.

Nemichthys scolopaceus. Posterior part of vertebral column and base of caudal fin in transitional adolescent, standard length 342 mm. Greatly enlarged.

anterior part of the body. The larval pigment spots are absent, though the internal, medullary spots are still present, as well as those on the dorsal side of the now practically enclosed intestine. Adult pigment continues to develop on the lower half of the body, except on the end of the caudal filament.

Transitional Adolescent: (Text-figs. 4 G, 5 G). Examples of this stage in the present collection, ranging from 300 to 360 mm., have already been discussed, on pp. 353 to 357. In relation to development, it will be seen that transitional adolescents differ from members of the preceding stage chiefly in the completely anguilliform proportions of the body, in the development of the teeth, in the spiniform aspect of the median rays of the dorsal fin and the elongation of the other finrays, and, finally, in the increase in pigmentation (in this stage there appears for the first time a slight amount of pigment on the lower part of even the end of the caudal filament). The immaturity of the specimens is shown in the incomplete pigmentation, in the fact that the dorsal fin has not quite reached its final position on the occiput, in the small degree of ossification, and, finally, in the immaturity of the gonads. The number of vertebrae in the caudal filament probably continues to increase throughout life.

ECOLOGY.

Seasonal Distribution: About half of the Bermuda specimens were taken in September, although the trawling season extended from April to September. These September examples included post-larvae, adolescents and transitional adolescents, but no larvae, the latter having all been taken earlier in the season.

Vertical Distribution: Except for two larvae, one at 50 fathoms and one at 400 fathoms, *Nemichthys* was taken only between 500 and 1,000 fathoms. Six-inch *nemichthyids*, however, were observed from the bathysphere at a depth of 75 fathoms.

Abundance: Next to *Serrivomer beanii* and *Eurypharynx pelecanoides*, *Nemichthys* is the most common deep-sea eel found in our Bermuda trawling area, 45 specimens having been taken in the nets. Among the Bermuda deep-sea fishes in general, however, the species is rare.

Sociability: Two *Nemichthys* came up in the same net on only four occasions. The three six-inch nemichthyids seen from the bathysphere were swimming in a group.

Food: Six of the larger specimens examined for food all had empty stomachs.

Viability: No *Nemichthys* has been taken alive.

STUDY MATERIAL.

The following list gives the catalogue number, net, depth in fathoms, date, length and growth stage of each specimen of *Nemichthys scolopaceus* taken by the Bermuda Oceanographic Expeditions. All were caught in the cylinder of water off the Bermuda coast described in *Zoologica*, Vol. XVI, No. 1, p. 5 and Vol. XX, No. 1, p. 1. "Trans. Adol." stands for "Transitional Adolescent."

No. 9,675; Net 49; 800 F.; Apr 29, 1929; 156 mm.; Larva.
No. 9,726; Net 56; 1,000 F.; April 30, 1929; 200 m.; Post-larva.
No. 11,015; Net 226; 700 F.; June 27, 1929; 104 mm.; Larva.
No. 11,074; Net 229; 1,000 F.; June 27, 1929; 45 mm.; Larva.
No. 11,353; Net 268; 700 F.; July 8, 1929; 242 mm.; Post-larva.
No. 11,692; Net 310; 600 F.; July 22, 1929; 230 mm.; Post-larva.

No. 12,438; Net 375; 800 F.; Aug. 15, 1929; 240 mm.; Post-larva.
No. 13,162; Net 430; 500 F.; Sept. 6, 1929; 202 mm.; Post-larva.
No. 13,513; Net 474; 700 F.; Sept. 9, 1929; ca. 300 mm.; Trans. Adol.
No. 13,644; Net 487; 800 F.; Sept. 21, 1929; ca. 240, ca. 285 mm.; Adolescents.
No. 13,709; Net 495; 800 F.; Sept. 23, 1929; 232, 294 mm.; Post-larva & Adolescent.
No. 13,754; Net 499; 800 F.; Sept. 24, 1929; 295 mm.; Adolescent.
No. 13,797; Net 505; 600 F.; Sept. 25, 1929; 357 mm.; Trans. Adol.
No. 14,850; Net 563; 600 F.; May 10, 1930; 38 mm.; Larva.
No. 15,302; Net 621; 600 F.; May 22, 1930; 40, 125 mm.; Larvae.
No. 15,459; Net 639; 700 F.; May 28, 1930; 312 mm.; Adolescent.
No. 17,153; Net 762; 1,000 F.; July 2, 1930; 245 mm.; Adolescent.
No. 16,957; Net 778; 700 F.; July 5, 1930; 245 mm.; Post-larva.
No. 16,955; Net 796; 1,000 F.; July 9, 1930; 210, 295 mm.; Larva, Post-larva.
No. 17,412; Net 810; 600 F.; Aug. 28, 1930; 253 mm.; Adolescent.
No. 17,413; Net 812; 600 F.; Aug. 28, 1930; 255 mm.; Adolescent.
No. 17,522; Net 824; 800 F.; Sept. 1, 1930; ca. 245 mm.; Adolescent.
No. 17,747; Net 834; 400 F.; Sept. 3, 1930; 226 mm.; Post-larva.
No. 17,786; Net 838; 600 F.; Sept. 3, 1930; 260 mm.; Adolescent.
No. 17,820; Net 842; 600 F.; Sept. 4, 1930; 305 mm.; Adolescent.
No. 18,004; Net 853; 500 F.; Sept. 6, 1930; 342 mm.; Trans. Adol.
No. 18,025; Net 855; 700 F.; Sept. 6, 1930; 220 mm.; Post-larva.
No. 18,066; Net 859; 500 F.; Sept. 8, 1930; 292 mm.; Adolescent.
No. 18,316; Net 867; 800 F.; Sept. 10, 1930; ca. 300 m.; Trans. Adol.
No. 18,451; Net 880; 500 F.; Sept. 12, 1930; 240 mm.; Adolescent.
No. 18,637; Net 893; 900 F.; Sept. 15, 1930; ca. 230 mm.; Post-larva.
No. 19,380; Net 946; 600 F.; Sept. 25, 1930; 235 mm.; Post-larva.
No. 19,477; Net 955; 1,000 F.; Sept. 28, 1930; 342 mm.; Trans. Adol.
No. 19,973; Net 967; 500 F.; Sept. 30, 1930; ca. 240 mm.; Adolescent.
No. 20,856; Net 1014; 400 F.; June 13, 1931; 85 mm.; Larva.
No. 21,002; Net 1041; 50 F.; June 26, 1931; 41 mm.; Larva.
No. 21,982; Net 1141; 800 F.; July 6, 1931; 184 mm.; Larva.
No. 22,310; Net 1161; 500 F.; Aug. 11, 1931; ca 250 mm.; Adolescent.
No. 22,750; Net 1195; 800 F.; Aug. 18, 1931; 210 mm.; Post-larva.
No. 23,293; Net 1283; 600 F.; Sept. 10, 1931; ca. 240 mm.; Adolescent.
No. 23,613; Net 1305; 500 F.; Sept. 15, 1931; 249 mm.; Adolescent.

Genus *Avocettina* Jordan and Davis, 1888.

Generic Characters: Nemichthyids with a single row of pores in the lateral line and the anus located far behind the level of pectoral base; caudal filament absent; teeth quincunxially arranged in straight rows; dorsal origin immediately behind level of pectoral base; dorsal rays in middle third of body neither short nor spinous.

Parietals separated by suture; supraoccipital absent; pterygoid vestigial, slender; mandible much shorter than ethmo-vomer; all opercular bones except preopercle present, although only feebly ossified; hyoid and branchial apparatus either moderately or very little ossified; a single hypohyal; ceratohyal short, distinct from epihyal from which arise the 7 to 12 branchiostegals, which are either short, or long and strongly curved; glossohyal, rudimentary or absent; urohyal slender, bifid basally; one or no basibranchial; both upper and lower coracoid present; four radials; vertebrae about 170 to 198; neuropophyses of caudal vertebrae spinous, arising from middle of centrum; three hypurals.

Discussion: Including Günther's description of the type species in 1878, five species of *Avocettina* have been described; namely, *A. infans* (Günther), 1878; *A. elongata* (Gill and Ryder), 1883; *A. gilli* (Bean), 1890; *A. bowersii* (Garman), 1899; and *A. exophthalma* Parr, 1932. Of these, *A. infans*, *A. elongata* and *A. exophthalma* were described from specimens taken in the Atlantic, while *A. gilli* and *A. bowersii* were from the eastern Pacific, having been caught off Alaska and Central America, respectively. Examples taken in the East Indies and Indian Ocean were referred by Brauer (1906) and Weber (1913) to the type species, *A. infans*, as were additional specimens recorded from the Atlantic by Jordon and Davis (1888), Norman (1930), Parr, with a query, (1932) and Roule (1933)[5]. We have examined at the Museum of Comparative Zoology the specimens referred by Borodin (1931) to *Nemichthys infans* and *Tilurella Nemichthydis infantis;* because of their characteristic myomeralcounts, larval pigment spots and rudimentary, but distinct, caudal filaments, we identify them as post-larval and adolescent examples of *Nemichthys scolopaceus*.

In the meantime Roule and Bertin (1929), having studied the 34 specimens taken by the *Dana* in the Atlantic and eastern Pacific, referred them all to *A. infans*, submitting the opinion that *A. infans*, *A. elongata*, *A. gilli*, and, more questionably, *A. bowersii*, were all probably synonymous. (*A. exophthalma* had not yet been described at the time of their work). Although settlement of the question will have to await a comparison of new material with the extensive *Dana* collection, as well as with the specimens from the East Indies and the Indian Ocean, nevertheless we have gathered evidence to show first, that *A. elongatus* is synonymous with *A. infans;* second, that the establishment of the validity of *A. gilli* must await a proper redefinition of *A. infans*, although the two are probably distinct; third, that *A. bowersii* is valid; and fourth, that probably at least one other species, as yet undescribed, has been already taken in the Atlantic. The single Bermuda specimen is included in the latter category.

In reaching these conclusions the following specimens in other collections have been examined:

1. *A. elongata* (Gill and Ryder), 1883: The unique specimen has been reexamined at the United States National Museum. Unfortunately, it is in very poor condition, with the upper jaw broken off short, the mandible missing entirely; the branchial and pectoral regions damaged; both pectoral fins, attached to a loose and twisted strip of abdominal skin, pulled far back out of place; and the first anal finrays uncountable. For these reasons, the only satisfactory proportion that could be taken was that of the interorbital breadth to the eye, in which it is contained about 1.9 times. A total of 198 pores was counted in the lateral line; supposing the usual number of about four pores to occur before the pectoral origin, a total of 194 pores are present on the trunk. The all important proportion of eye into postorbital distance cannot be determined because of the hopelessly damaged pectoral region; all that can be said is that the eye and postorbital both appear to be moderate—that the first is contained in the second, say, somewhere around three times. In spite of the somewhat large number of pores in the lateral line, it seems best, since the pores were not counted in the type specimen of *A. infans*, to emphasize the narrow interorbital and apparently moderate postorbital and eye, and synonymize *A. elongata* with *A. infans*.

2. *A. gilli* (Bean), 1890: The unique specimen of this Alaskan species also was examined at the United States National Museum. As in *A. elongata*, both jaws are broken off short, so that most measurements could not be taken. The eye is contained in the postorbital about 2.2 times, the interorbital in the eye more than twice. There are 177 or 178 pores in the

[5] When he found that the type specimen of *Gavialiceps tinayrei* Zugmayer (1914) was a typical *Avocettina*.

lateral line behind the pectoral origin and three in front of it. The anal originates at the vertical between the eighteenth and nineteenth pores behind the pectoral base. Accurate branchiostegal and finray counts cannot be secured without careful dissection or staining. With *A. infans* established as the variable species it is now understood to be, *A. gilli* may actually prove to be synonymous with it. It seems far more likely, however, that it will prove to be a distinct species, as is often found to be the case, with so-called cosmopolitan forms from the Pacific, when sufficient material becomes available. In any case, *A. gilli* is distinct both from the Atlantic *A. exophthalma,* characterized by the broad interorbital space, and from the small-eyed Pacific form, *A. bowersii.*

3. *A. bowersii* (Garman), 1899: The type specimen was examined at the Museum of Comparative Zoology, and Garman's original description and figure found to be accurate. Specimens taken by the Templeton Crocker Expedition of the New York Zoological Society off the coast of Lower California added as a further check to the unquestionable validity of this very distinct form with small eyes, many branchiostegals and few dorsal rays. Without doubt the *Dana* specimens from Panama recorded by Roule and Bertin belong also to this species (Roule and Bertin, 1929, p. 26, Table VI, nos. 6 to 15, 17-20, 24-27 and 29[6]).

In regard to the remaining species, *A. exophthalma* and *A. infans,* of which the types have not been examined, the following conclusions are drawn:

A. exophthalma Parr, 1932: This West Indian species with its wide interorbital space and large eye is almost certainly valid. It is likely that Specimen No. 3 of Roule and Bertin, and possibly also their young Specimen No. 30, belong to this species.

A. infans Günther, 1878: The type species, left to include the remaining known specimens, still embraces exceptionally diverse examples. Even when the Panamanian species of Roule and Bertin, and those mentioned above under *A. exophthalma,* are omitted from the list, there are still such wide variations in the proportions of remaining Atlantic specimens that it seems that more than one species must be involved. An example is the variability of the eye, which is contained in the postorbital distance 2.8 to 4.7 times. Although the latter figure is typical of the Pacific species, *A. bowersii,* still that form is distinguished by the fewer number of dorsal finrays (around 255 instead of around 340).

In the following study, the single Bermuda specimen is shown to differ from apparently typical *A. infans* in its greater interorbital width, larger eye, longer snout and smaller postorbital distance. For the following reasons, however, it is not designated as the type of a new species: First, it is intermediate in position between *A. infans* and *A. exophthalma.* Secondly, the type material of *A. infans* requires a reexamination, in the light of the material which has accumulated since the publication of the description. Thirdly, it is probable that Specimen No. 23 of Roule and Bertin from the West Indies belongs to the same species as the Bermuda specimen, if the latter does prove to be distinct. The same may be true of their Specimen No. 21, of one or both of Günther's smaller specimens and of Parr's (1932) damaged, 390 mm. example. This material should all be examined before a new species is established especially because, fourth and finally, the Bermuda specimen is in poor condition due to unforeseen decomposition in clearing and staining (after measurements were made), and it seems inadvisable to designate it as the type of a new species in a genus already so confused. It is hoped that the following description, which is

[6] No. 28 from Panama does not agree, as Parr has already pointed out (1932, pp. 11-12). The localities of the numbered *Dana* specimens have been determined from a comparison of their lengths with specimens of corresponding lengths tabulated geographically in Roule and Bertin, 1929, p. 27, Table VII.

complete save for the dorsal fin count, will leave no doubt as to the specimen's proper taxonomic position when more material is gathered and the question settled.

Avocettina sp.

SPECIMEN TAKEN BY THE BERMUDA OCEANOGRAPHIC EXPEDITIONS.

1 specimen; July 2, 1930; 1,000 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.; standard length 498 mm.

DESCRIPTION.

(Text-figs. 10, 11).

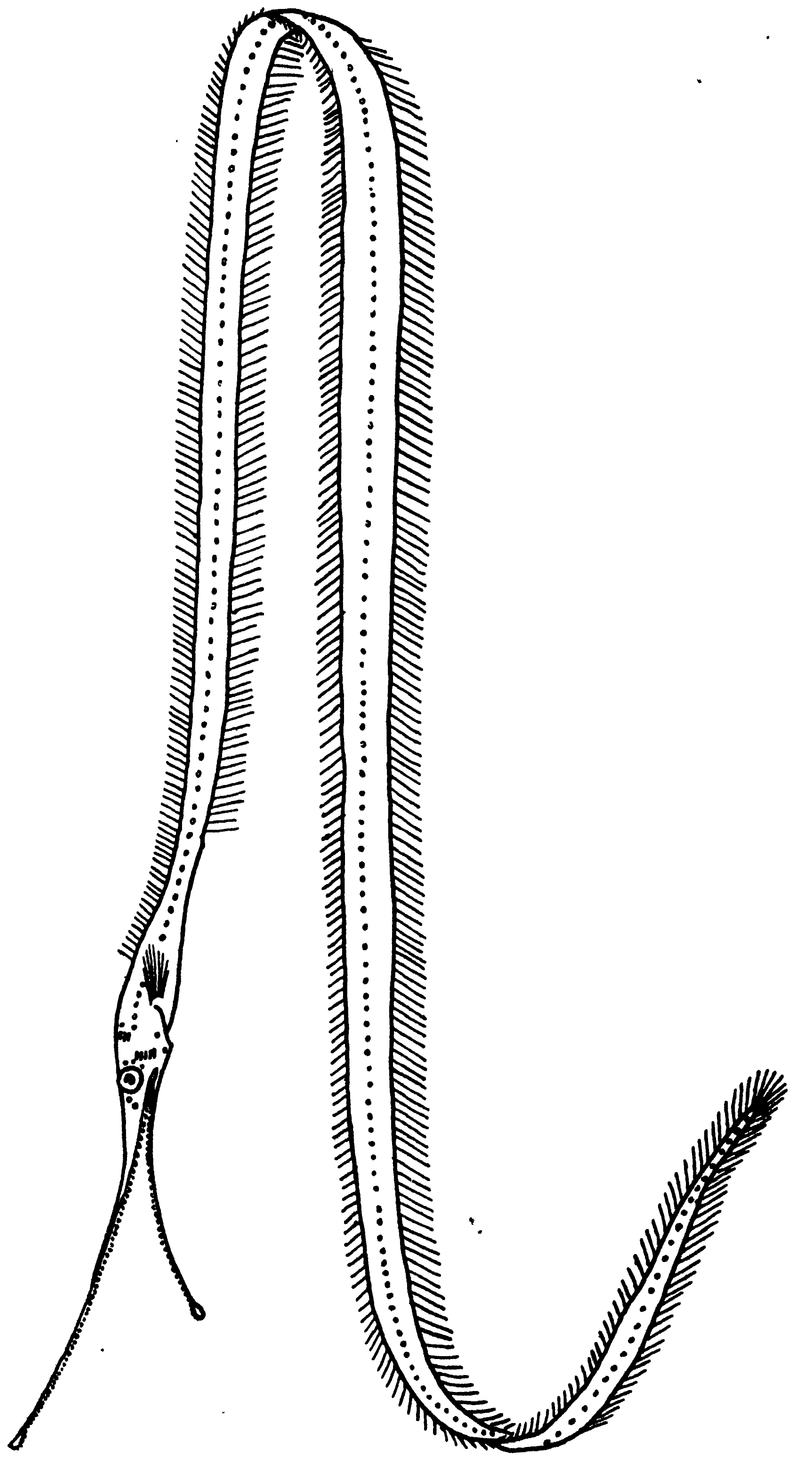
(With comparative notes on specimens of *Avocettina bowersii* from the Pacific).

Color of Fresh Specimen: Dark brown, spotted ventrally with black.

Measurements and Proportions: Length 498 mm.; depth at pectoral base 7 mm. (in length 71.1 or 1.4 %); maximum depth (187 mm. in front of end of tail) 8 mm. (in length 62.3 or 1.6 %); minimum depth (30 mm. behind eye) 3.5 mm. (in length 142 or 0.7 %); head 63 mm. (in length 7.9 or 12.7 %); eye 3.66 mm. (in head 17.2, in postorbital 2.4, 0.74 % of length); snout 53.4 mm. (in head 1.2, 10.7 % of length); postorbital 8.6 mm. (in head 7.3, in snout 6.2, 1.73 % of length); interorbital 3.2 mm. (in head 19.7, in eye 1.1, 0.64 % of length); tip of snout to posterior end of maxillary 57.5 mm., extending slightly behind posterior margin of orbit; tip of mandible to angle of jaw 36.5 mm.; tip of snout to tip of mandible 15.7 mm. (in snout 3.4, 3.2 % of length); pectoral base to dorsal origin 5.2 mm. (in postorbital 1.7, 1.04 % of length); pectoral base to anal origin 43 mm. (5 times postorbital length of head, 8.6 % of length); pectoral length 9 mm.; caudal length 4.4 mm.

Teeth: (Text-figs. 3B, 12, 13, 14). The entire inner face of the flattened maxillary is covered with minute, backwardly directed teeth arranged irregularly in quincunx: along the slender anterior edge they form a single row; farther back, at the widest portion of the bone, there are 12 rows, while at the posterior end the number is reduced to six. The teeth on the mandible and ethmo-vomer are larger and directed more sharply backward than those on the maxillary. The upper surface of the mandible and the lower surface of the ethmo-vomer are both strongly arched, their reverse sides being flattened; the teeth on both bones cover the entire surface of the arch, extending halfway or more to the border of the flattened surface, except near the anterior end. Here, where the bones become very slender and laterally compressed, the teeth are reduced to a single row along the apex. Beyond this point are the well-defined, swollen terminal knobs, both the upper and lower being well provided with irregularly set teeth. Both in this species and in a 431 mm. specimen of *Avocettina bowersii* taken off Lower California (see p. 374, Specimen No. 24,795, for data) there are at the broadest portion of the bones 13 rows of teeth, arranged in perfect quincunx, on both the ethmo-vomer and the mandible. In the present specimen about 260 teeth are placed in the mid-line of the ethmo-vomer posterior to the terminal knob.

Fins: Pectoral rays 17, originating under third to fourth lateral line pore, the first ray expanded and strongly developed, the second similar, but strengthened to a lesser degree. Dorsal and anal rays damaged, not countable; dorsal origin behind pectoral base above sixth lateral line pore

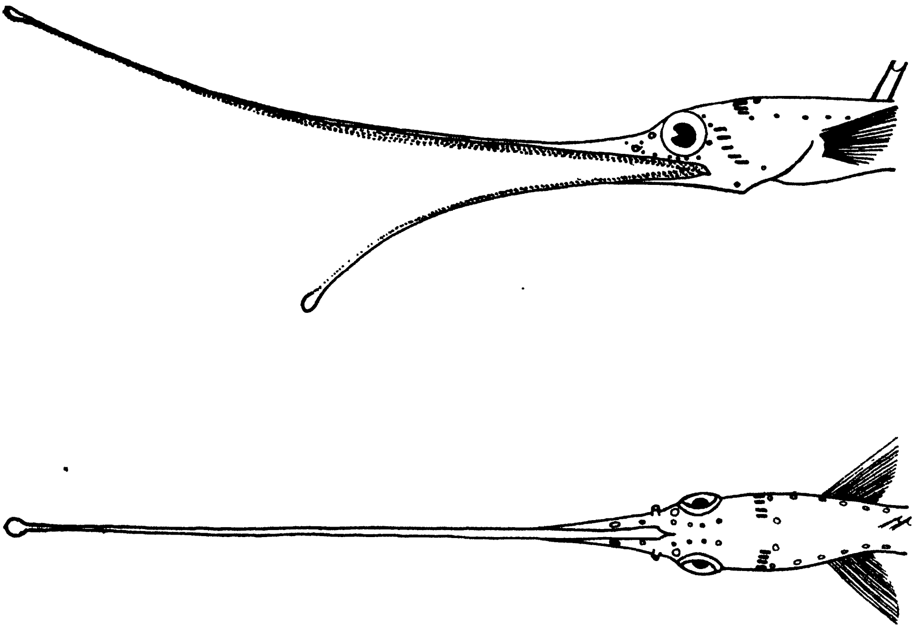


Text-figure 10.
Avocettina sp. Standard length 498 mm. The complete numbers of fin rays are not indicated.

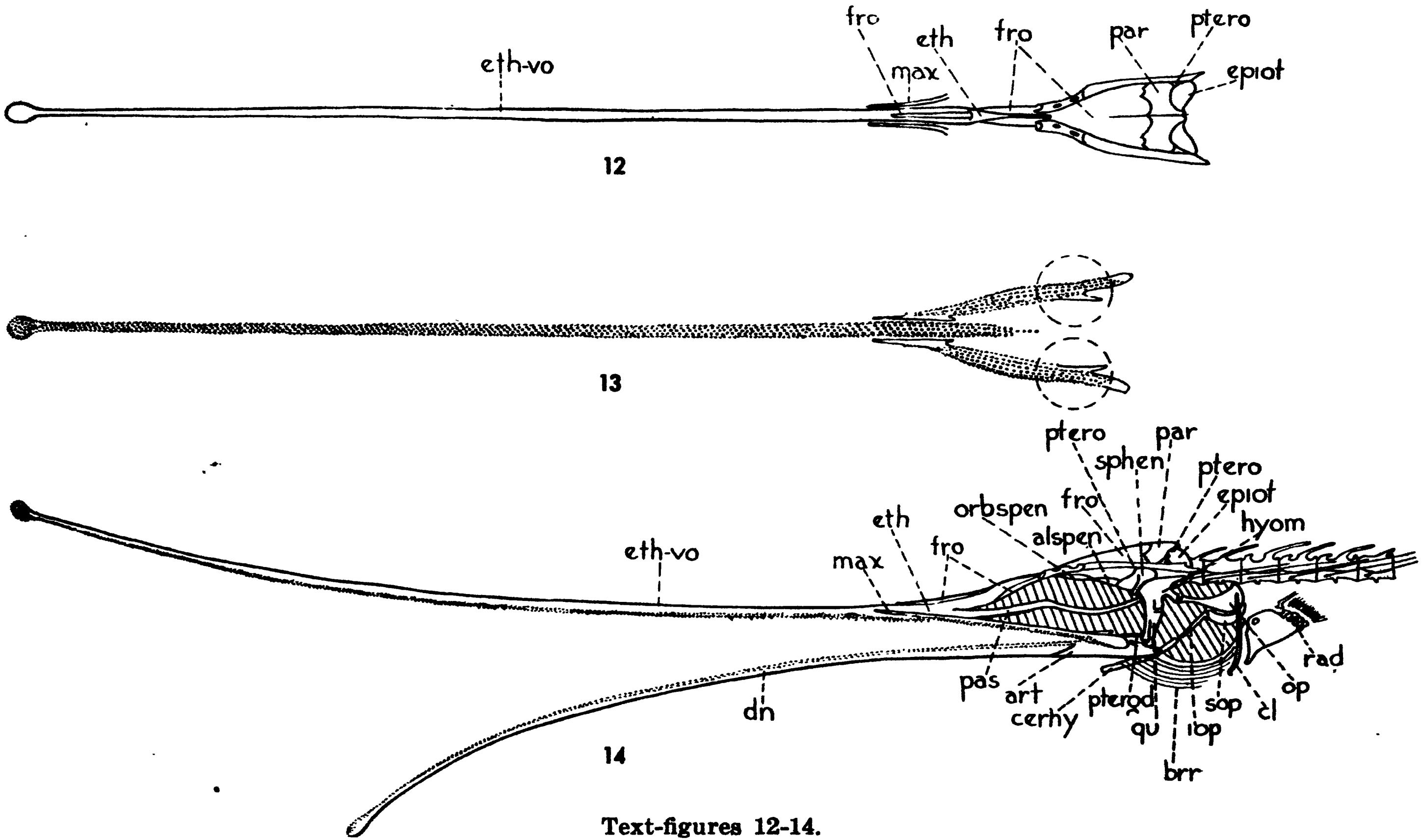
(third behind pectoral origin); anal origin under twenty-third lateral line pore (twentieth behind pectoral origin). Except for the first, short rays, the dorsal and anal rays both are longest in the anterior two-thirds of the body; anal rays about twice as long as dorsal, more than half maximum depth of body at that point. Caudal rays five.

Pores and Vertebrae: There were 195 pores in the lateral line, the first three occurring in front of the pectoral base. Because of the decomposition of the trunk during clearing, it is impossible to count the vertebrae; however, in the specimen of *Avocettina bowersii* mentioned above, the number of vertebrae exactly coincided with the total number of lateral line pores (175), so that in all probability equally similar results would have been obtained could the vertebral count have been obtained for the Bermuda specimen.

Osteology: (Text-figs. 12-16). With the characteristics of the genus. Hyoid apparatus very feebly ossified; seven short branchiostegals, corresponding to the lack of space between pectoral and opercle—i.e., the shortness of the postorbital region. (The specimen described by Trewavas (1932, p. 650) had the branchiostegals "much bowed," while those of *Avocettina bowersii* are similarly bowed, and very long in addition, corresponding to the more spacious postorbital region). Branchial apparatus entirely cartilaginous except for moderately well ossified pharyngobranchials. (In *Avocettina bowersii* the entire hyoid and branchial apparatus, though composed of delicately slender bones, are well ossified). Cleithrum at level of second vertebra, first pectoral ray at end of third. (In *Avocettina bowersii* the cleithrum is more slender, and falls at the level of the fifth vertebra, while the first pectoral ray is underneath the sixth). The vertebral column is almost entirely unossified, although the dorsal and anal rays, the pectoral fin, and all fin supports show moderate amounts of ossification. This is all in contrast to the skeleton of *Avocettina bowersii*, which is relatively well

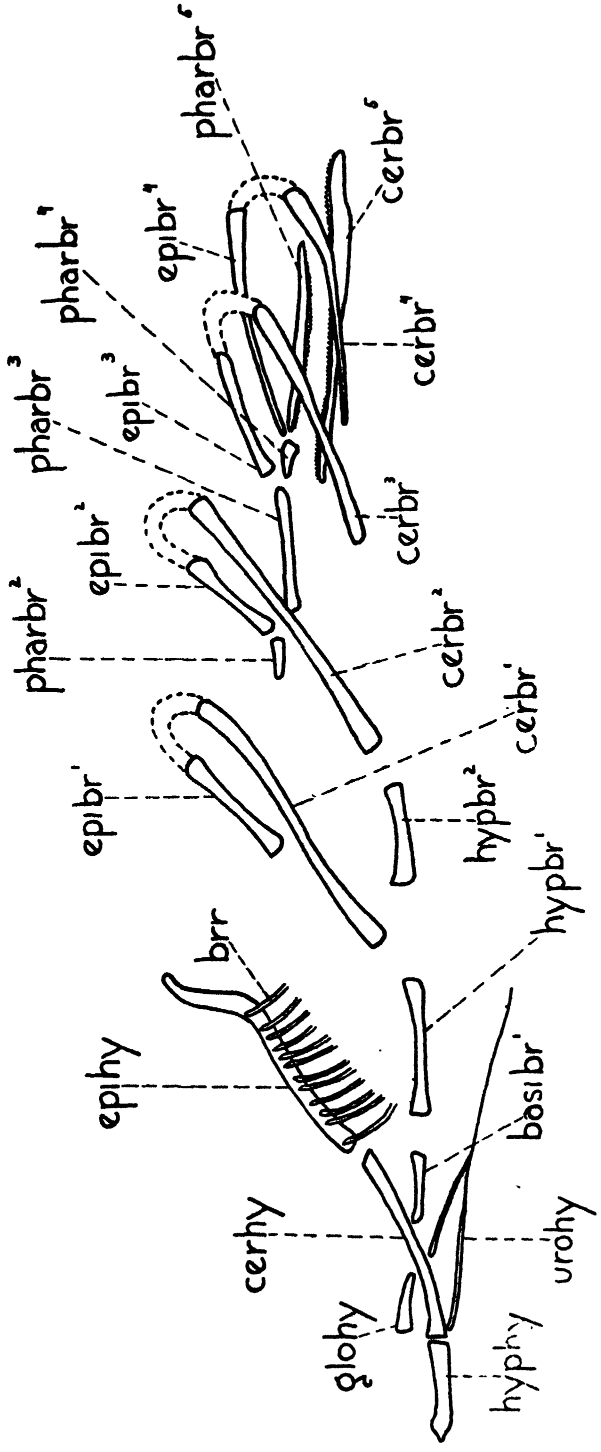


Text-figure 11.
Avocettina sp. Head, lateral (upper) and dorsal (lower) views. Standard length 498 mm. (x 1.6).

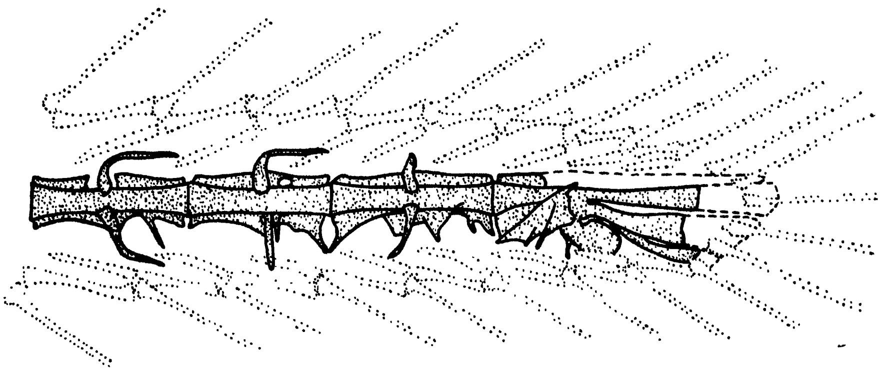


Text-figures 12-14.

Avocettina sp. **12.** Skull of adult, dorsal view; standard length 498 mm. (x 2.6). **13.** Same, teeth of upper jaw and vomer, ventral view. (x 2.6). **14.** Same, bones of head, pectoral girdle and anterior part of vertebral column, lateral view. (x 2.6).



Text-figure 15.
Avocettina sp. Hyoid and branchial apparatus of adult, standard length 498 mm. (x 18.4).



Text-figure 16.
Avocettina bowersii. Posterior part of vertebral column and base of caudal fin in adult, standard length 431 mm. (x 17.5).

ossified throughout. Since the tail of the Bermuda specimen of *Avocettina* sp. disintegrated during the clearing and staining process, a figure of the caudal vertebrae of *Avocettina bowersii* is included in this paper (Text-fig. 16). The tails of two specimens of this species were examined—that of the one referred to above, and another, slightly smaller example (for data see below, Specimen No. 25,783), and were found to be practically identical, both in the strong degree of ossification of the vertebrae, finrays and supports and in structure. The characteristic elements of the latter are the three hypurals and the irregular flange of bone directed forward and downward which arises on each side of the last vertebra. The neural spines arise from the center of the centrum, not from the posterior portions, as Trewavas states is the case in *Nematoprora polygonifera* (loc. cit. p. 649).

Coelomic Organs: With the characteristics of the family. All of the internal organs with the exception of the speckled kidney are entirely unpigmented. The kidney, commencing 12 mm. behind the pectoral base, is traceable to within 35 mm. of the tip of the tail. The specimen is a female, with scarcely developed ovaries. Starting at the level of the anus, they are visible as slender strands of tissue until their termination 212 mm. behind the pectoral base.

Study Material.

1. A single specimen of *Avocettina* sp. taken by the Bermuda Oceanographic Expedition, in the cylinder of water off the Bermuda coast described in *Zoologica,* Vol. XVI, No. 1, p. 5:

No. 16,667; Net 762; 1000 F.; July 2, 1930; 498 mm.; Adult.

2. Specimens of *Avocettina bowersii* taken by the Templeton Crocker Expedition to the Gulf of California and Clarion Island (see *Zoologica,* Vol. XXII, No. 2, pp. 33-46; "The Templeton Crocker Expedition. II. Introduction, Itinerary, List of Stations, Nets and Dredges," by William Beebe):

a. No. 24,795; Sta. 134 T-2; 450 F.; March 30, 1936; 431 mm.; Adult; from 12 m. SW. of Cape Falso, Lower California.

b. No. 25,783; Sta. 165 T-2; 400 F.; May 17, 1936; 410 mm.; Adult; from 145 m. N. of Clarion Island, Revilla Gigedos.

Genus ***Labichthys*** Gill and Ryder, 1883.

Generic Characters: Nemichthyids with a single row of pores in the lateral line and the anus close behind level of pectoral base; caudal filament absent; teeth alternating in straight rows; dorsal origin slightly in advance of level of pectoral base; dorsal rays in middle third of body not short or spinous.

Parietals separated by suture; supraoccipital present; pterygoid vestigial, slender; mandible slightly shorter than ethmo-vomer; all opercular bones except preopercle present, but only feebly ossified; hyoid and branchial apparatus scarcely ossified; a single hypohyal; ceratohyal short, distinct from epihyal from which arise the eight strongly curved branchiostegals; basibranchials apparently absent; one coracoid; four radials; vertebrae about 175 to 180.

Labichthys, with a supraoccipital present, pterygoid vestigial but apparent and an opercular apparatus relatively well developed is, in these important characters at any rate, the least specialized of all the Nemichthyidae (with the possible exception of *Cercomitus*, which has not yet been studied osteologically).

Discussion: Only a single species, *L. carinatus* Gill and Ryder, 1883, has been described which belongs in this genus. *L. elongatus* Gill and Ryder, 1883, *L. gilli* Bean, 1890, and *L. bowersii* Garman, 1899, have, since their description, all been properly referred to *Avocettina*.

The three specimens of *L. carinatus* which have been previously taken are, respectively, the type and the two examples recorded by Parr (1932 and 1934). The present specimens agree well with the recorded measurements.

Labichthys carinatus Gill & Ryder, 1883.

Specimens Taken by the Bermuda Oceanographic Expeditions.

3 specimens; April to August, 1929 to 1931; 500 to 1,000 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12′ N. Lat., 64° 36′ W. Long.; standard lengths 200+ to 470 mm.

Specimens Previously Recorded.

3 specimens; about 450 to 906 fathoms; western North Atlantic; recorded lengths 447 mm. and 605 mm.

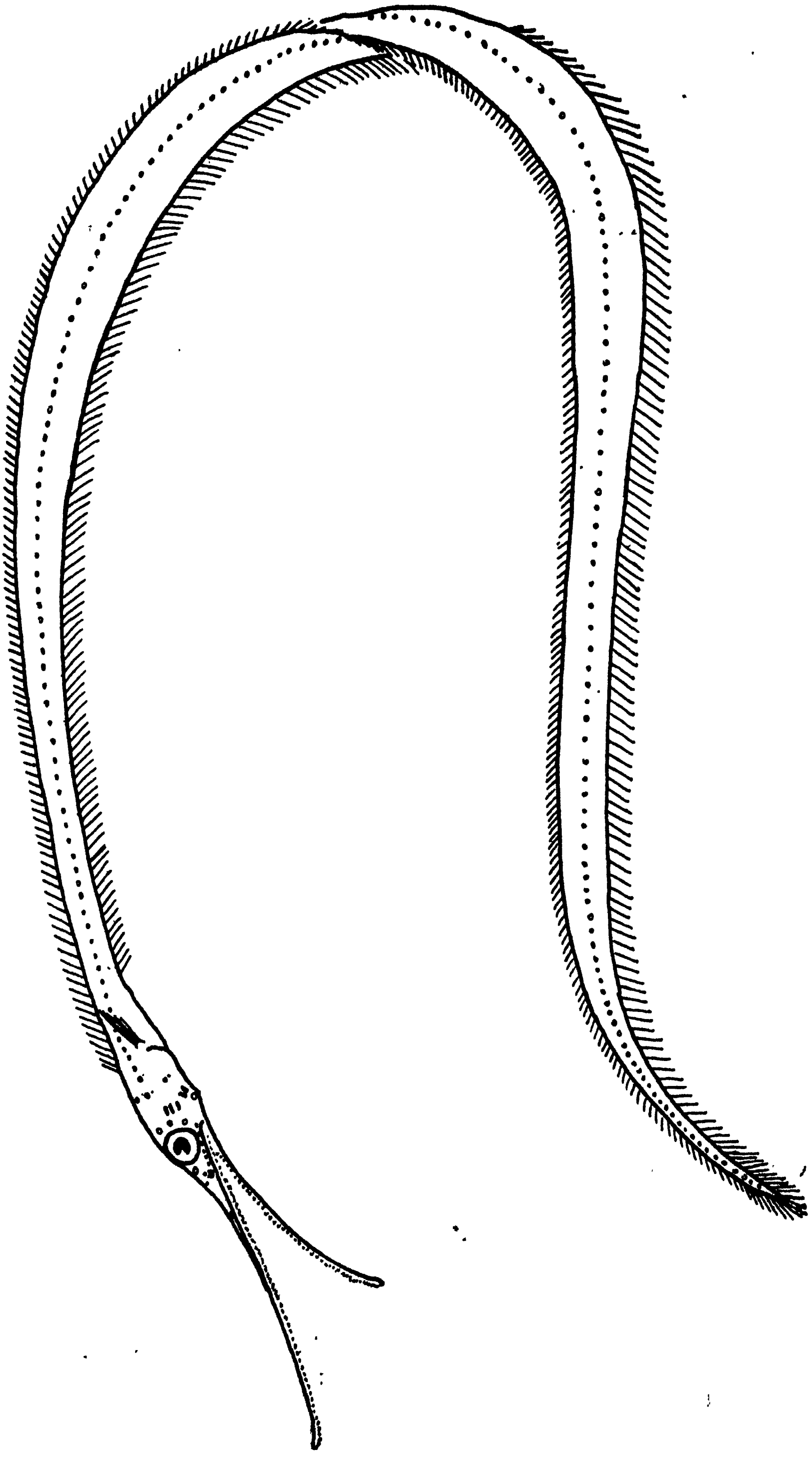
Description of Adult.

(Text-figs. 17, 18).

(From the two largest Bermuda specimens, 352 and 470 mm. in length; the smallest, 200+ mm. specimen was too badly damaged for exact measurements and counts to be made).

Color of Recently Preserved Specimens: Plain dark brown.

Proportions: Maximum depth (near middle of body) in length 36 to 41.5 (2.4 % to 2.8 %); head in length 7 to 7.6 (13.2 % to 14 %); eye in head 12.4 to 12.8, in postorbital 2.3 to 2.6, (1.06 % to 1.1 % of length); snout in head 1.36 to 1.39 (9.7 % to 10.3 % of length); postorbital in head 4.1 to 5, in snout 3.6 to 4, (2.5 % to 2.8 % of length); interorbital in head 15.6 to 16.5, in eye 1.2 to 1.3, (0.8 % to 0.9 % of length); maxillary extending slightly beyond posterior margin of orbit; tip of snout to tip



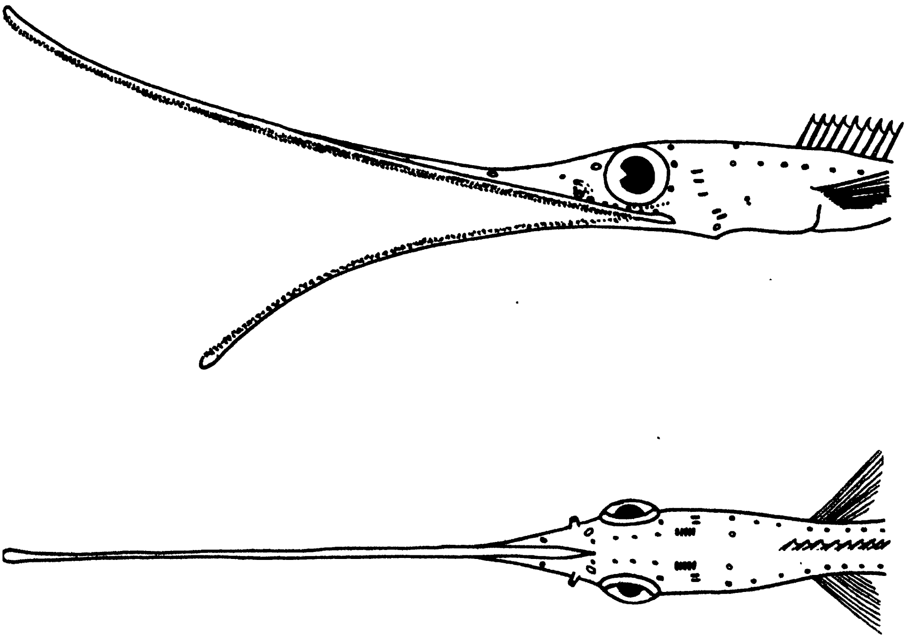
Text-figure 17.
Labichthys carinatus. Standard length 470 mm. The complete numbers of fin rays are not indicated.

of mandible in length of snout 3.1 to 3.2 (3 % to 3.3 % of length); pectoral base to anal origin in postorbital length 1.3 to 1.4 (2 % of length).

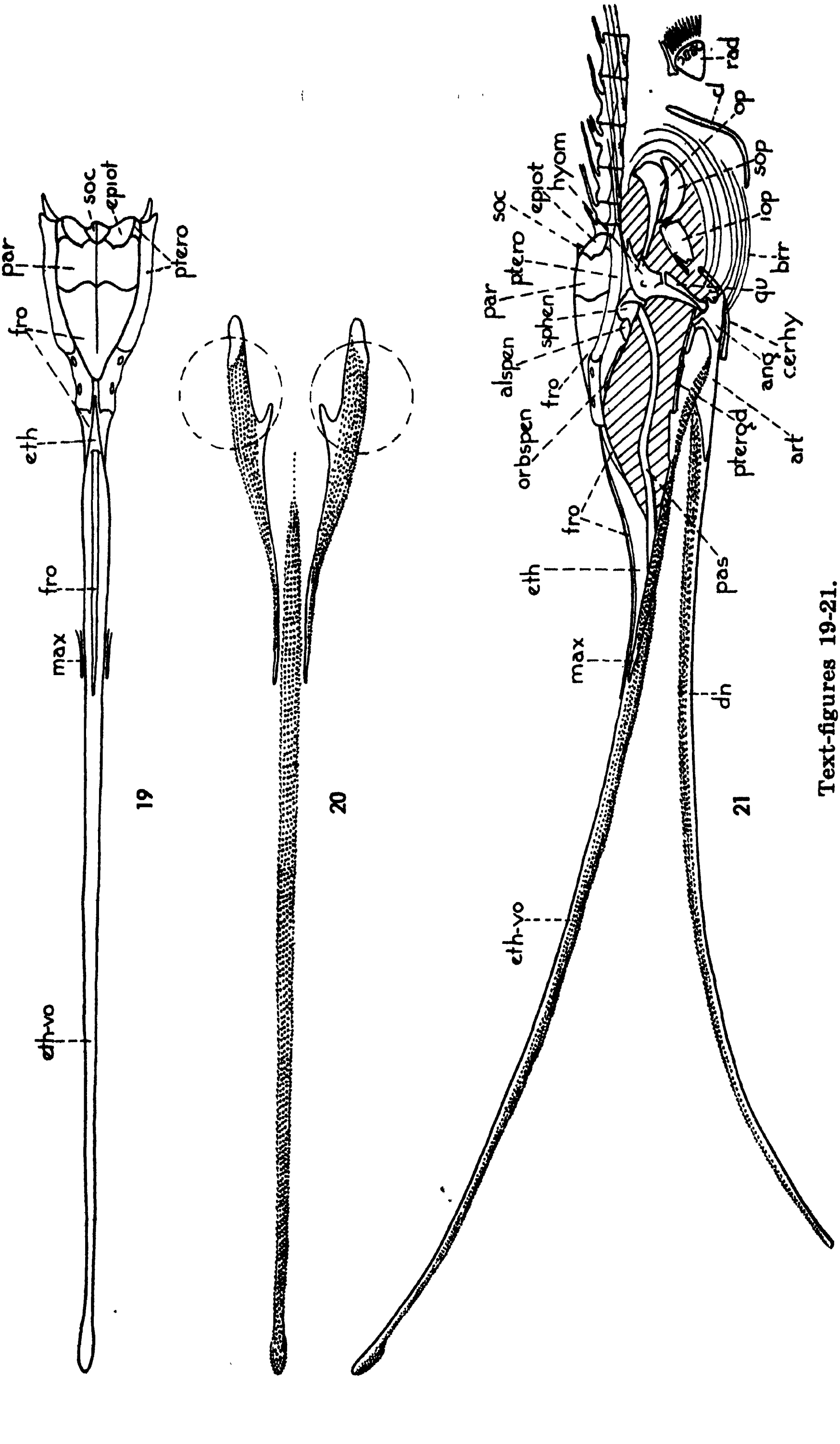
Teeth: (Text-figs. 3A, 19, 20, 21). The dentition of *Labichthys* agrees closely with that of *Avocettina* (see page 369) except in the following details: there are only 9, not 13, rows of teeth both on the mandible and on the ethmo-vomer; the teeth of the latter bones are more slender than those either on the mandible or than those of *Avocettina;* finally, there is a total of only about 220 teeth in a straight line along the mid-line of the ethmo-vomer, instead of about 260, as in both *Avocettina* sp. and *A. bowersii.* Both jaws are furnished with terminal knobs, but the latter are smaller and more elongate, less spherical than in *Avocettina.*

Fins: Pectoral rays 13, originating under second to fourth dorsal ray and beneath third to seventh lateral line pore, the dorsal origin, therefore, being slightly in front of pectoral base. (In the type specimen, which was reexamined by us at the United States National Museum, the pectoral commences under the sixth pore). First pectoral ray expanded and thickened, second and third similar, but smaller. Dorsal and anal rays so damaged that their numbers cannot be counted or their relative lengths determined, except that the anal rays are, as usual in this group, considerably longer than the dorsal rays. The anal originates under the eleventh to thirteenth dorsal ray and the seventh to twelfth lateral line pore. (In the type the anal commences under the space between the ninth and tenth pores; in the type description a count of 268 dorsal and 287 anal rays is given).

Pores and Vertebrae: There are 176 and 179 pores in the lateral line, the first three to six occurring in front of the pectoral base. An equal number of vertebrae was found in the specimen which was cleared and stained. (In the type there are 180 pores).

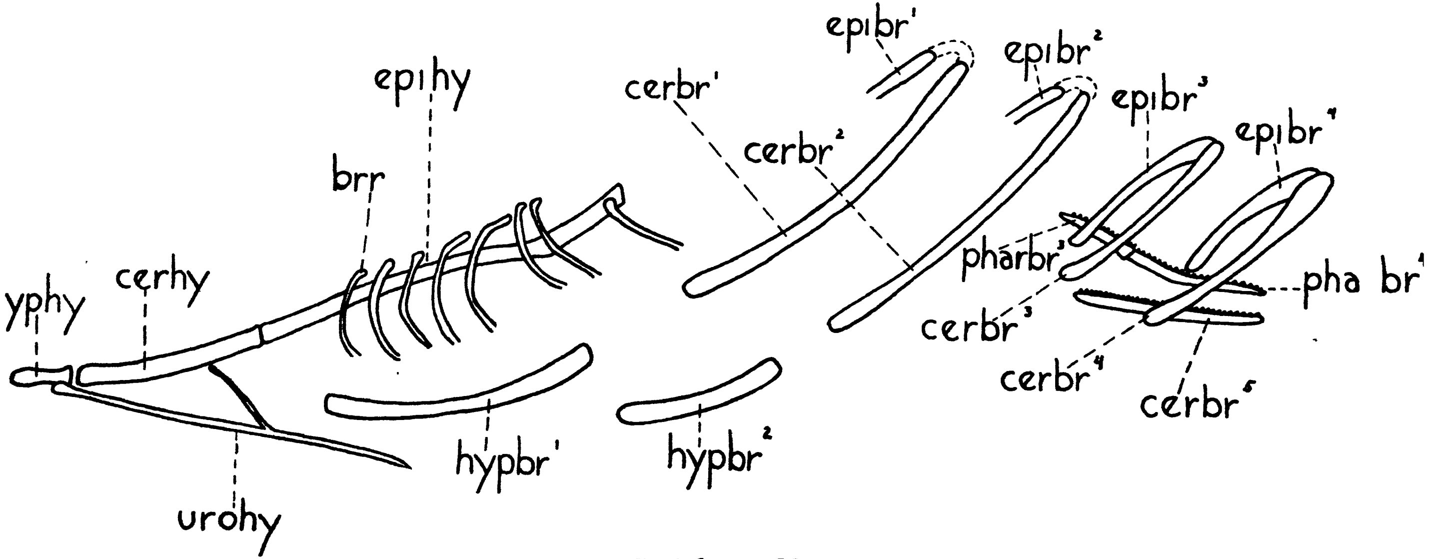


Text-figure 18.
Labichthys carinatus. Head, lateral (upper) and dorsal (lower) views. Standard length 470 mm. (x 1.8).



Text-figures 19-21.

Labichthys carinatus. **19.** Skull of adult, dorsal view; standard length 470 mm. (x 3.1). **20.** Same, teeth of upper jaw and vomer, ventral view. (x 3.1). **21.** Same, bones of head, pectoral girdle and anterior part of vertebral column,



Text-figure 22.
Labichthys carinatus. Hyoid and branchial apparatus of adult, standard length 470 mm. (x 16.4).

Osteology: (Text-figs. 19-22). With the characteristics of the genus. Unfortunately the entire trunk, including the vertebral column, fins and tail, fell to pieces during the staining process, so that no details can be given of this region except that the vertebral column appeared to be fairly well ossified and the dorsal and anal finrays strongly so. The jaws and pectoral fin were likewise strongly stained, but the rest of the skull as well as the hyoid and branchial apparatus showed exceedingly little ossification.

Discussion: The present specimens agree well with the type specimen. With the percentages given by Parr (1932, p. 16) for a 605 mm. specimen, our smaller examples differ in having relatively slightly shorter snouts (9.7 % to 10.3 %, not 11.9 %, of length) and smaller eyes (1.06 % to 1.1 %, not 1.16 %, of length). The postorbital length of the head is identical, relative to the length, in all three specimens, although the distance from pectoral base to anal origin is again slightly smaller in the present specimens (2 % instead of 2.8 % of length). Another slight difference is that in our specimens the eye and the dorsal rim of the orbit do not protrude so far above the line of the snout and skull, as depicted in Parr's Fig. 9 (1932, p. 18). Finally, the interorbital width in our specimens is greater than in Parr's (0.8 % to 0.9 %, instead of 0.73 %, of length).

The rostral ridges which, by their prominence in the shrunken type, gave the species its name, are not, as Parr has pointed out, very noticeable in fresh specimens. From the present drawing of the skull (Fig. 19) it will be seen that the ridges are merely the postero-lateral edges of the ethomo-vomer which fold up over the anterior end of the frontal. The same general effect is found in both *Avocettina* and *Nemichthys*.

Study Material.

The following list gives the catalogue number, depth in fathoms, date of capture, length and growth stage of each specimen of *Labichthys carinatus* taken by the Bermuda Oceanographic Expeditions. All were caught in the cylinder of water off the Bermuda coast described in *Zoologica*, Vol. XVI, No. 1, p. 5.

No. 9,704; Net 36; 900 fathoms; April 24, 1929; 352 mm.; Adult.
No. 16,459; Net 756; 1,000 fathoms; July 1, 1930; 470 mm.; Adult.
No. 22,309; Net 1143; 500 fathoms; Aug. 7, 1931; 200+ mm.; Adult.

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28.

Caudal Skeleton of Bermuda Shallow Water Fishes. III. Order Iniomi: Synodontidae.[1]

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(Text-figures 1-18).

OUTLINE.

INTRODUCTION.

This is the third of a series of papers dealing with the caudal skeleton of Bermuda fishes[2]. The shallow-water Iniomi of Bermuda are represented by one family, two genera and three species.

In identifying specimens of the genus *Synodus*, before preparing them for osteological study, all the material runs to *S. intermedius* and *S. foetens*. All characters agree with Norman's "A Revision of the Lizard-Fishes of the Genera *Synodus*, *Trachinocephalus*, and *Saurida*." P.Z.S. of London, 1935.

For Caudal Fin Terminology, complete Bibliography, and method of preparing specimens for this study refer to Part I.

The length of specimens in this paper is standard length unless otherwise stated.

I am indebted to the United States National Museum for two specimens of *Trachinocephalus myops*.

This opportunity is taken to thank Dr. William Beebe, Director of this department, and Mr. John Tee-Van, General Associate, for their cooperation.

The drawings are by Mr. George Swanson and the author.

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[1] Contribution No. 548, Department of Tropical Research, New York Zoological Society. Contribution from the Bermuda Biological Station for Research Inc.

[2] Caudal Skeleton of Bermuda Shallow Water Fishes. I. Order Isospondyli: Elopidae, Megalopidae, Albulidae, Clupeidae, Dussumieriidae, Engraulidae. *Zoologica*, New York Zoological Society, Vol. XXI, Dec. 31, 1936.

Caudal Skeleton of Bermuda Shallow Water Fishes. II. Order Percomorphi, Suborder Percesoces: Atherinidae, Mugilidae, Sphyraenidae. *Zoologica*, New York Zoological Society, Vol. XXII, Oct. 7, 1937.

KEY TO CAUDAL FIN OF BERMUDA SHALLOW WATER INIOMID FISHES.

INIOMI

Synodontidae

Group I — *Trachinocephalus myops*

1 simple vertebra, anterior to true caudal, without ribs, epipleural spines and haemal process.

Abdominal ribs present beyond the anterior margin of anal fin, extending to about mid-length and above 7th anal ray.

55 total vertebrae.

46 trunk vertebrae.

Group II

4 to 7 simple vertebrae, anterior to true caudal, without ribs, epipleural spines and haemal processes.

Abdominal ribs absent beyond the anterior margin of anal fin.

58 or 49 total vertebrae.

Sub-Group A — *Synodus foetens*

4 simple vertebrae anterior to true caudal.

Posterior interhaemal anal spine higher than long.

58 total vertebrae.

38 trunk or abdominal vertebrae with ribs.

Sub-Group B — *Synodus intermedius*

6 or 7 simple vertebrae anterior to true caudal.

Posterior interhaemal anal spine longer than high.

49 total vertebrae.

30 trunk or abdominal vertebrae with ribs.

This paper deals principally with the adult fishes, as does Part I on Bermuda Isospondyli and Part II on Bermuda Percomorphi, suborder Percesoces.

The Synodontidae are unlike the families studied in Parts I and II in having between the trunk and the typical caudal region vertebrae which lack ribs, characteristic of the trunk, and which also lack closed haemal arches bearing haemal spines, characteristic of the caudal. This area is immediately posterior to the abdominal or trunk region and dorsal to the anal fin whose interhaemals project upward almost to the vertebrae. Definite bottom living habits of this elongate fish may be responsible for the ventral modification of the vertebrae in this region above the anal fin.

In *Synodus* the posterior pair of ribs is dorsal to the anterior margin of the anal fin. In *Trachinocephalus* the posterior pair of ribs is dorsal to the anal fin at its mid-length. In a broad sense the caudal region of the synodonts includes all the vertebrae posterior to the last abdominal or trunk vertebra bearing ribs. In this paper the general caudal is divided into the anterior or precaudal and the posterior or true caudal. The precaudal includes all of the modified vertebrae posterior to the last trunk vertebra and anterior to the true caudal. The true caudal is the typical caudal, the vertebrae of which have closed haemals bearing spines.

The differences in the total vertebral counts of the three species is found in the trunk region and there is only slight variance in the counts of the precaudal and the caudal.

In the trunk region the ventral projections or stumps from the bases of the centra are called parapophyses, according to Starks' "Synonomy of the Fish Skeleton." In the precaudal and the true caudal regions the ventral projections are called zygapophyses according to the definition of caudal bones in Part I.

The true caudal of *S. foetens* and *S. intermedius* are so essentially similar that no illustrations have been included of the latter. The differences are described in the text.

The symbols used are: AD, adipose; AN, anal fin; BA, basiost; C, centrum; EP, epural; ES, epipleural spine; HA, haemal arch; HP, haemal process; HS, haemal spine; IS, interhaemal spine; NA, neural arch; NP, neural process; NS, neural spine; P, parapophysis; R, rib; SNP, specialized neural process; UN, uroneural; UR, urostyle; Z, zygapophysis; 1, 2, 3, etc., hypurals.

1. ***Trachinocephalus myops*** (Forster).

(Text-figs. 1-4).

Diagnostic Characters:

1 simple vertebra anterior to the true caudal without ribs, epipleural spines and haemal process.

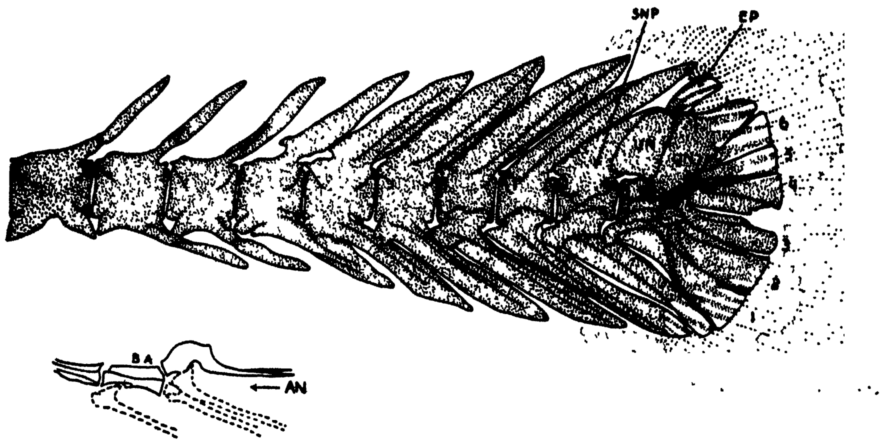
Posterior pair of ribs at about mid-length of anal fin, dorsal to the 7th anal ray.

Epipleural spines present above the entire length of the anal fin.

Vertebral count: 46 trunk. Total 55.

Material Studied.

Length.	*KOH Cat. No.*	*Cat. No.*	*Text-fig. No.*
275 mm.	2201	83784 U. S. Nat. Mus.	1
90 mm.	2200	71053 U. S. Nat. Mus.	
39 mm.	2174		2, 3
29 mm.	2139		4

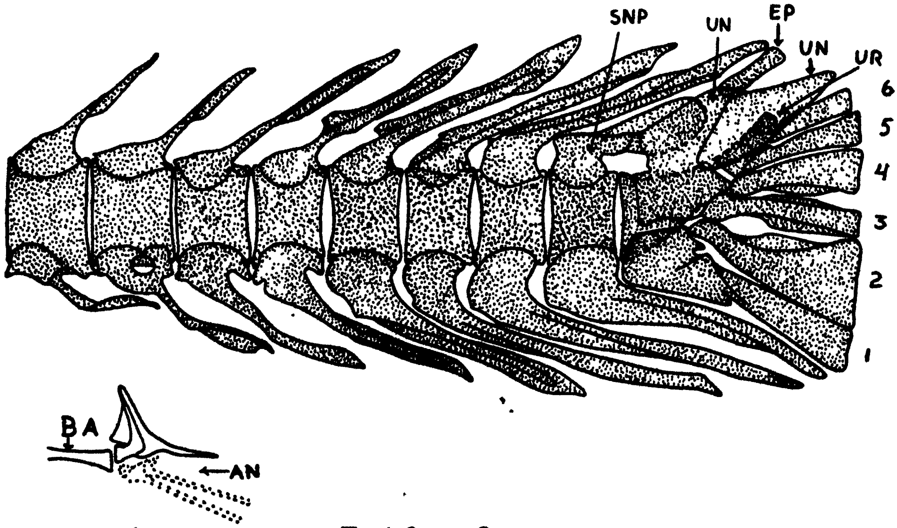


Text-figure 1.

***Trachinocephalus myops*. Tail of 275 mm. specimen showing the entire true caudal series following the last precaudal vertebra. (x 2.6).**

Caudal Osteology.

Urostyle: In the 275 mm. specimen all except the anterior margin of the urostyle is covered by the uroneurals (Text-fig. 1). The visible part of the urostyle is identical in size and shape with the penultimate centrum. The notochord extends beyond the distal margin of the hypurals between the bifid base of the ninth ray, counting up from the median line. In the 39 mm. and 29 mm. specimens, where the ossification of the uroneurals overlapping the urostyle is not as dense as in the 275 mm. specimen, separate elements of the urostyle can be seen. These are less ossified in the



Text-figure 2.

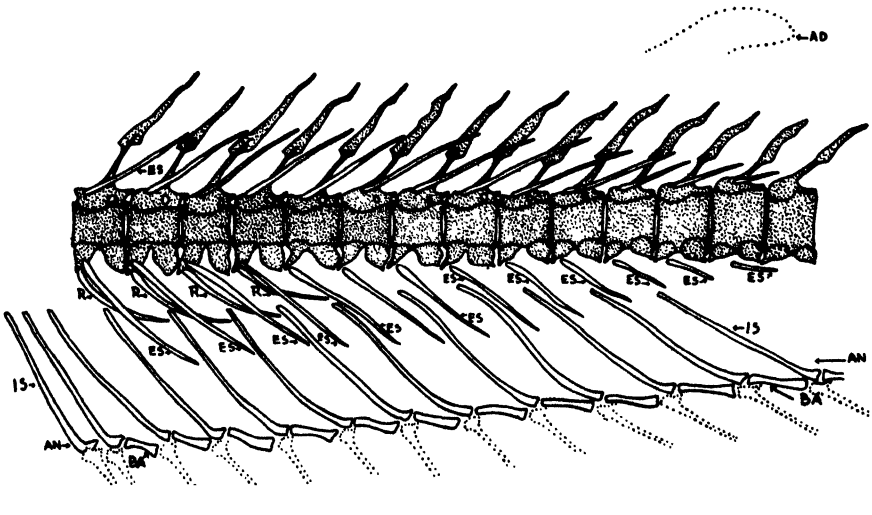
***Trachinocephalus myops*. Tail of 39 mm. specimen showing the entire true caudal series and the specialized neural process of the penultimate vertebra projecting between the adjacent uroneurals. (x 21.1).**

29 mm. fish and there is a longer unossified area between the two segments. All the elements of the urostyle in the 39 mm. specimen are more consolidated and more heavily ossified than in the 29 mm. fish (Text-figs. 2, 3, and 4).

Uroneurals: There are two pairs of uroneurals, in all the specimens examined, which overlap and cover the urostyle and almost fill the area above and between the last neural spine and the sixth hypural (Text-figs. 1, 2, and 4). By dissecting, a third pair was found fused to the distal and inner surfaces of the posterior uroneurals. Dorsally, the shape of the two large pairs of uroneurals, separately and together, differs from *Synodus foetens*. In *Trachinocephalus* the bones of both pairs of uroneurals are larger (Text-fig. 1). In *Synodus foetens* the epural, and not the uroneurals, fills most of the area above the anterior uroneurals whereas the reverse is true in *Trachinocephalus*. In this fish the posterior pair of uroneurals elongate anteriorly, covering most of the lateral parts of the anterior pair and the bases of the hypurals. In *Synodus foetens* a third pair of uroneurals is present on the lateral part of the urostyle and the posterior pair, comparable with that of *Trachinocephalus*, is entirely dorsal to the urostyle (Text-fig. 5).

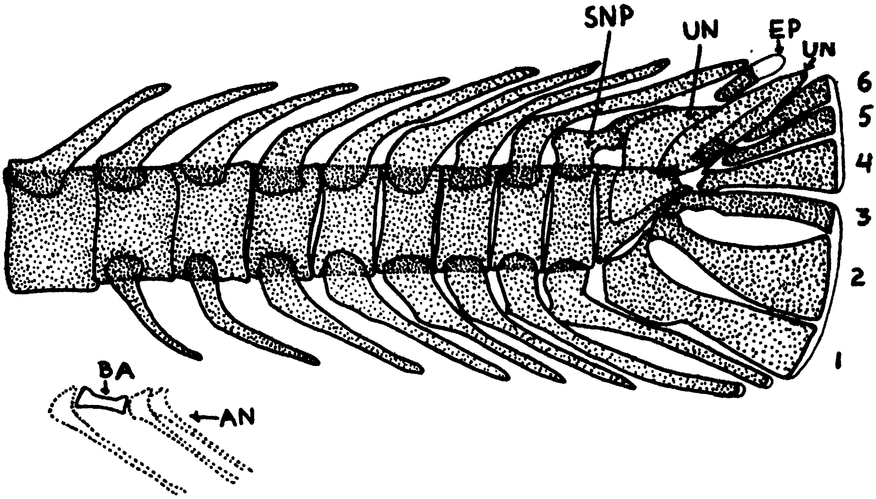
Hypurals: There are six hypurals, three below and three above the median line. There is no space between the dorsal and ventral surfaces of these bones but they remain unfused even in the largest specimen. In the smallest specimen examined a continuous band of cartilage covers the distal ends of the hypurals (Text-fig. 4).

Epurals: There is one epural in all specimens. In the 29 mm. fish the distal half is unossified (Text-fig. 4). The epural in the 275 mm. specimen is rectangular-shaped and twice as long as wide (Text-fig. 1). In *Synodus foetens* of 300 mm. the epural is a much longer bone with a slender dorsal tip which resembles the adjacent neural spine. Ventrally, it becomes broader



Text-figure 3.

***Trachinocephalus myops*. Precaudal series of tail of 39 mm. specimen following the last four trunk vertebrae. At the right is the one simple vertebra preceding the true caudal series. Below is the anal fin with interhaemal spines projecting dorsally and overlapping the epipleural spines. (x 13.3).**



Text-figure 4.

Trachinocephalus myops. Tail of 29 mm. specimen showing the entire true caudal following the one simple vertebra of the precaudal series. Ossification is not complete, which is shown by the partly ossified epural and unossified interhaemals. A band of cartilage outlines the distal margin of the hypurals. (x 21.1).

and fills the area above the uroneurals, which are not as large as those of *Trachinocephalus.*

Specialized Neural Processes: On dissecting the neural process of the centrum preceding the urostyle, a median dagger-like projection was found which extends posteriorly within the uroneurals uniting dorsally the penultimate and urostyle centra (Text-figs. 12, 13, and 14). This is also found in *Synodus.*

Caudal Fin Ray Count:

275 mm.	13 + 9 = 22
	13 + 10 = 23
39 mm.	13 + 10 = 23
29 mm.	13 + 9 = 22

Additional Characters Worthy of Note: There are ten vertebrae between the trunk and the true caudal series which are called precaudal in this paper. These vertebrae lack ribs, characteristic of the trunk, and also closed haemals bearing haemal spines, characteristic of the typical caudal. Ventrally, the haemal canal is open between the stump-like zygapophyses. Nine centra of this series bear epipleural spines whose lengths decrease posteriorly. At the caudal end of the series there is one simple vertebra which is anterior to the beginning of the true caudal series. This vertebra lacks ribs, epipleural spines, and haemal processes. The last pair of epipleural spines is dorsal to the posterior interhaemal spine of the anal fin. Following the ten precaudals is the true caudal series consisting of nine typical caudal vertebrae, counting the urostyle segment as one. The position of the anterior true caudal vertebra is dorsal to the basiost which articulates the posterior and penultimate anal rays. Besides the differences in the various counts one conspicuous general difference between *Trachinocephalus* and

Synodus is the much heavier development of the neural and haemal processes of the true caudal of *Trachinocephalus.*

The description, in general, was taken from the two smaller specimens because the place of capture of the larger fish was not Bermuda.

2. *Synodus foetens* (Linnaeus).

(Text-figs. 5-18).

Diagnostic Characters:

Posterior interhaemal anal spine higher than long.

4 simple vertebrae, anterior to the true caudal series, without ribs, epipleural spines and haemal processes.

Last posterior pair of ribs on the centrum which is anterior by two centra to the anterior external margin of the anal fin.

Epipleural spines present on centra to about the mid-length of the anal fin.

Vertebral count: 38 trunk. Total 58.

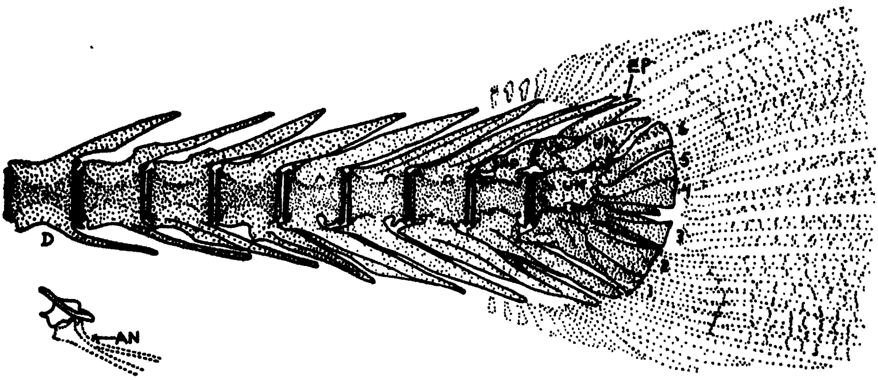
Material Studied.

Length.	*KOH Cat. No.*	*Text-fig. No.*
300 mm.	1081	5, 6, 8, 12-18
153 mm.	770	
130 mm.	997	7
75 mm.	2176	
45 mm.	2177	
33 mm.	2181	
32 mm.	2180	10
28 mm.	2182	11

Caudal Osteology.

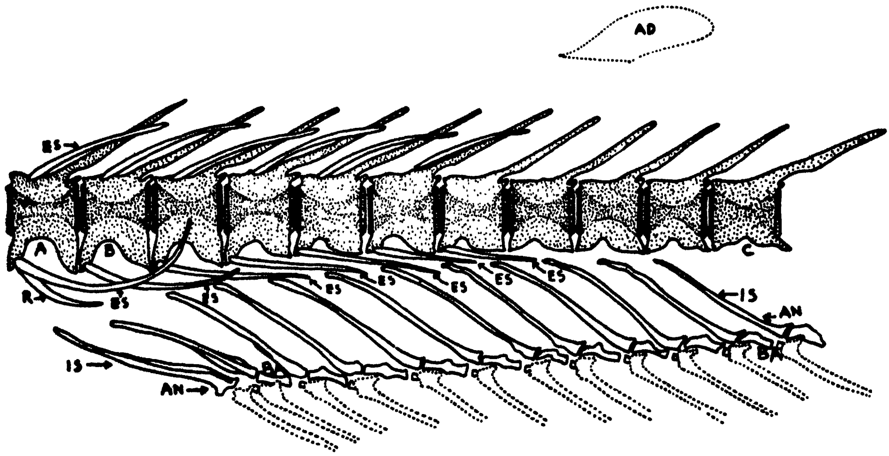
Urostyle: In the 300 mm. specimen all except the anterior margin of the urostyle segment is covered by the uroneurals and, ventrally, by the bases of the first and second hypurals. The anterior margin is identical in form with that of the preceding centrum. The clear notochord extends beyond the margin of the hypurals between the bifid base of the 10th ray, counting up from the median line. The notochord extends 5.25 mm. beyond the tips of the posterior dorsal pair of uroneurals (Text-figs. 5 & 12). In the 130 mm. specimen the posterior end of the urostyle is seen through the overlying uroneurals and located above the bases of the fourth and fifth hypurals. Beyond is a short unossified area which is followed by a small hour-glass-shaped bony segment dorsal to the bases of the fifth and sixth hypurals. The cartilaginous notochord extends between the uroneurals beyond the distal margin of the sixth hypural (Text-fig. 7). In the 75 mm. specimen the terminal bony segment, comparable with that of the 130 mm. specimen, is slightly longer and there is less unossified area between it and the preceding segment. It is more rod-like and lacks the hour-glass shape of the larger specimen (Text-fig. 8). Text-figures 10 and 11 show the development of the urostyle in specimens 32 mm. and 28 mm. in length.

Uroneurals: In the 300 mm. specimen three pairs of uroneurals overlap each other on the surface of the urostyle (Text-figs. 5 and 12). By dissecting, a diminutive fourth pair was found fused to the distal end and inner surface of the posterior-dorsal uroneurals (Text-figs. 7 and 8). In a 75 mm. specimen this small pair of uroneurals is unfused and separate from the overlapping uroneurals (Text-fig. 9). In the two smallest specimens, 32 mm. and 28 mm., only one pair of the large uroneurals is developed.



Text-figure 5.

Synodus foetens. Tail of 300 mm. specimen showing the entire true caudal and the relative position of the posterior interhaemal of the anal fin. See Text-figure 18 for front view of vertebra D. (x 2.1).



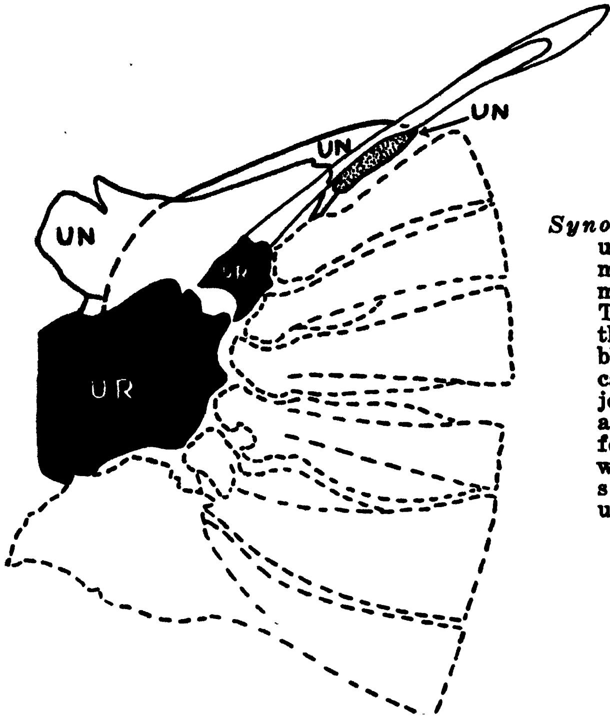
Text-figure 6.

Synodus foetens. Precaudal of tail of 300 mm. specimen following the last vertebra. At the right are the four simple vertebrae preceding the true caudal and below is the anal fin with interhaemals overlapping dorsally the ends of the epipleurals. See Text-figures 15, 16 and 17 for front views of vertebrae A, B and C. (x 2.1).

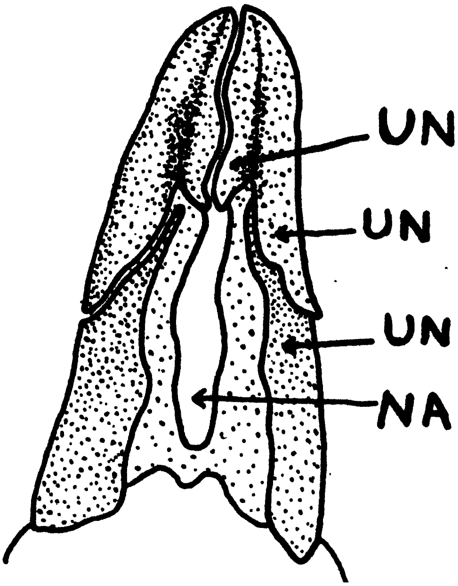
Hypurals: There are six hypurals, three below and three above the median line. Although the hypurals in the 300 mm. specimen have no space between the dorsal and ventral surfaces, these bones are not fused. In the smallest fish a band of cartilage outlines the distal margin of the hypurals (Text-fig. 10).

Epurals: There is one epural in specimens of all lengths. In the smallest the epural is unossified and in the 32 mm. specimen one quarter remains unossified (Text-figs. 10 and 11).

Specialized Neural Processes: In dissecting the neural process of the centrum preceding the urostyle a median dagger-like projection was found which extends posteriorly within the uroneurals uniting dorsally the penul-

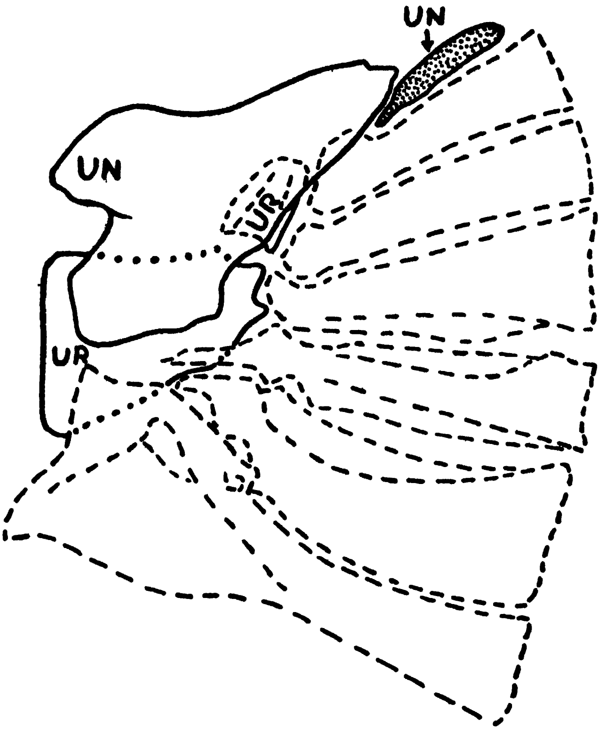


Text-figure 7.
Synodus foetens. Dissected urostyle of 130 mm. specimen with all uroneurals removed from upper side. Two ossified elements of the urostyle are shown in black and in outline, the cartilaginous notochord projecting beyond. The stippled area is one bone of the fourth pair of uroneurals which are fused to the inner surface of the dorsal uroneurals. (x 21.8).

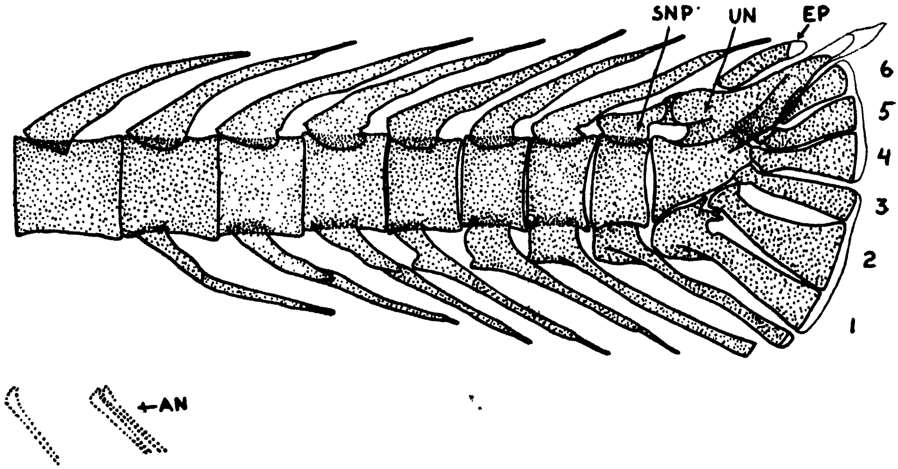


Text-figure 8.
Synodus foetens. The overlapping uroneurals above the urostyle in the 300 mm. specimen as seen from the posterior. The upper UN represents the small uroneurals stippled in Text-figure 7. (x 11.8).

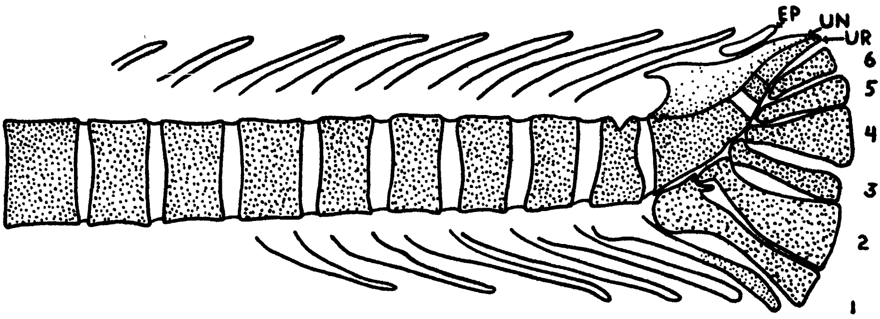
timate and urostyle centra (Text-figs. 12, 13, 14). In the smallest specimen, 28 mm., which is only partially ossified, this neural process is not present (Text-fig. 11). But in the 32 mm. fish it is present and ossified (Text-fig. 10).



Text-figure 9.
Synodus foetens. Urostyle of 75 mm. specimen with the posterior dorsal uroneurals removed to show the small underlying pair which are unfused in this young specimen. (x 36).



Text-figure 10.
Synodus foetens. Tail of 32 mm. specimen showing entire true caudal following the posterior simple vertebra of the precaudal series. Part of the epural and none of the internal bones of the anal fin are ossified. A cartilaginous band outlines the distal margin of the hypurals. (x 26.8).



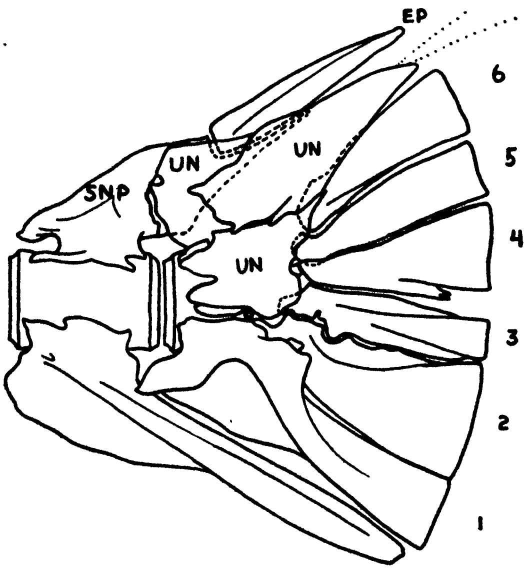
Text-figure 11.

Synodus foetens. Tail of 28 mm. specimen showing vertebral column unsegmented and only partly ossified. None of the neurals or haemals is ossified. (x 21).

Caudal Fin Ray Count:

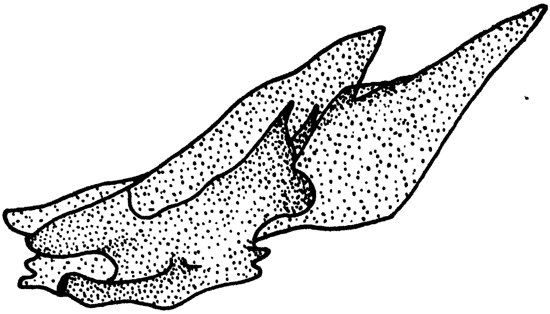
300 mm.	12 + 10 = 22
45 mm.	11 + 9 = 20
75 mm.	13 + 10 = 23
	12 + 9 = 21
32 mm.	11 + 8 = 19
	9 + 10 = 19
28 mm.	12 + 8 = 20
	11 + 9 = 20

Additional Characters Worthy of Note: There are ten precaudal vertebrae between the trunk and the true caudal series. These vertebrae lack ribs and closed haemals with haemal spines (Text-fig. 6). Ventrally, the haemals are open between the stump-like zygapophyses (Text-figs. 16 and



Text-figure 12.

Synodus foetens. Urostyle with penultimate vertebra of 300 mm. specimen showing in dashed line the median projection of the specialized neural process between the uroneurals. Also in dashed line are the bases of the hypurals which are covered by the uroneurals in the completely ossified specimen. (x 5.1).



Text-figure 13.

Synodus foetens. Lateral view of specialized neural process of penultimate centrum of 300 mm. specimen dissected to show single posterior projection which extends between the bones of two pairs of uroneurals seen in Text-figure 12. (x 10.4).

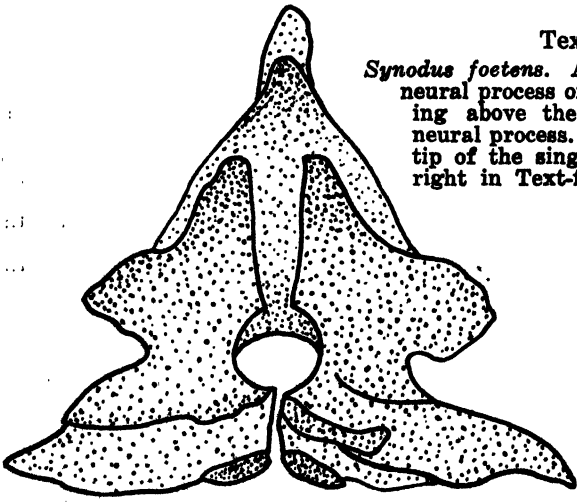
17). The six anterior centra of this series have epipleural spines whose lengths decrease posteriorly. Following the six are four simple vertebrae, anterior to the true caudal, without ribs, epipleural spines and haemal processes. The position of the last pair of epipleural spines is dorsal to the mid-length of the anal fin (Text-fig. 6). There are nine typical caudal vertebrae, counting the urostyle segment as one (Text-fig. 18). The anterior caudal vertebra is dorsal to the last interhaemal spine of the anal fin (Text-fig. 5). The interhaemals are long and stout and extend upward and in an anterior direction from the articulating basiosts almost to the centra.

3. *Synodus intermedius* (Agassiz).

Diagnostic Characters:

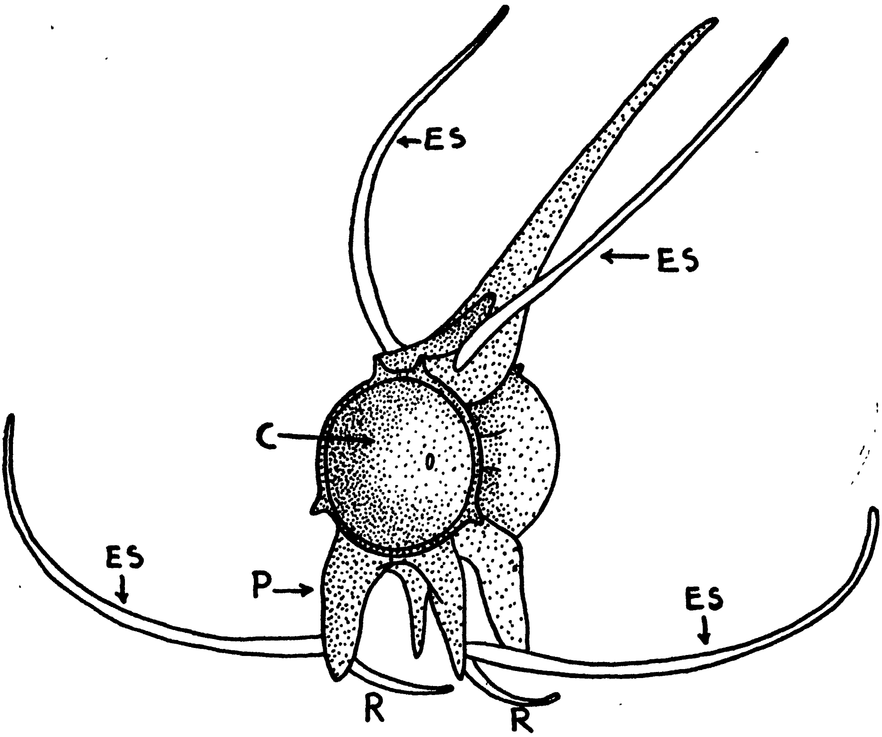
Posterior interhaemal anal spine longer than high.

6 or 7 simple vertebrae, anterior to the true caudal series, without ribs, epipleural spines, and haemal processes.



Text-figure 14.

Synodus foetens. Anterior view of specialized neural process of penultimate centrum showing above the neural canal the reduced neural process. The dorsal projection is the tip of the single median bone seen on the right in Text-figure 13. (x 23.2).



Text-figure 15.

Synodus foetens. Posterior trunk vertebra of 300 mm. specimen with ribs, epipleural spines and open haemal. This vertebra is lettered A in Text-figure 6. (x 30.3).

Last posterior pair of ribs on the centrum which is anterior by three centra to the external anterior margin of the anal fin.

Last posterior pair of epipleural spines on the centrum dorsal to the external anterior margin of the anal fin.

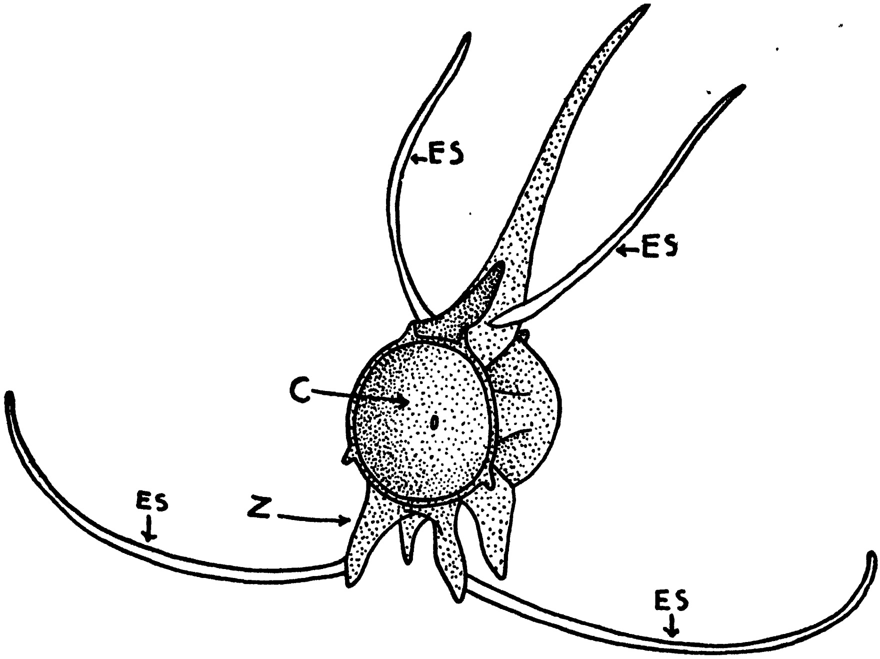
Vertebral count: 30 trunk. Total 49.

Material Studied.

Length.	*KOH Cat. No.*
270 mm.	493
202 mm.	638
135 mm.	677
50 mm.	2175

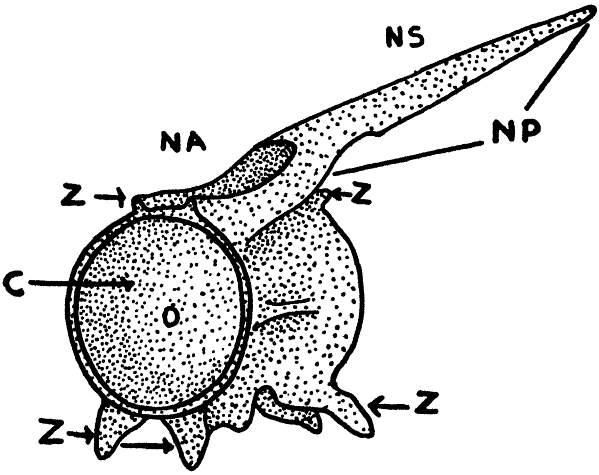
Caudal Osteology.

The general caudal pattern of *Synodus intermedius* is similar to that of *Synodus foetens* but differences of detailed structure make it easy to distinguish between the two species. *S. intermedius* is shorter and more compact than *S. foetens* as is primarily shown by a comparison of the vertebral counts. *S. intermedius* is shorter by eight to ten vertebrae, which difference is found in the trunk region. The precaudal and caudal counts of the two species are almost the same. In *S. intermedius* the anal fin is notice-



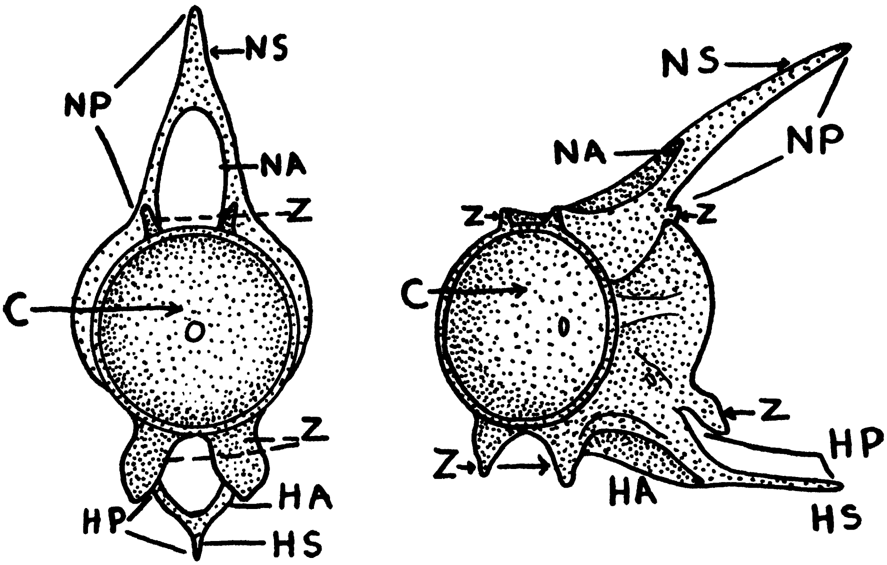
Text-figure 16.

Synodus foetens. First precaudal vertebra of 300 mm. specimen which follows the vertebra shown in Text-figure 15. It is lettered B in Text-figure 6. (x 30.3).



Text-figure 17.

Synodus foetens. The posterior simple vertebra of the precaudal series of a 300 mm. specimen which lacks ribs, epipleural spines and has an open haemal. This vertebra is penultimate to the true caudal series and is lettered C in Text-figure 6. (x 8.2).



Text-figure 18.

Synodus foetens. The anterior and first vertebra of the true caudal series of a 300 mm. specimen showing closed haemal process with haemal spine. This vertebra is lettered D in Text-figure 6. (x 6.1).

ably shorter with fewer rays and interhaemals. In the precaudal region of *S. foetens* there is a greater number of simple vertebrae which are dorsal to the entire anal fin. Epipleural spines are present on only three or four anterior centra of the precaudal series leaving six or seven simple vertebrae. On the urostyle the ventral pair of uroneurals is much smaller than that of *S. foetens.* The base of the first hypural extends dorsally covering almost the lower half of the urostyle and, from above, the base of the anterior-dorsal uroneurals extends down over the urostyle. Between these two bones and entirely lateral in position is an insignficant pair of uroneurals. The anterior hypurals are more sharply pointed and the neural processes in the precaudal area are considerably heavier than those of *S. foetens.*

Caudal Fin Ray Count:

270 mm.	12 + 9 = 21
135 mm.	11 + 10 = 21
202 mm.	12 + 9 = 21
	12 + 10 = 22
50 mm.	12 + 10 = 22
	11 + 9 = 20

INDEX

Names in bold face indicate new species; numbers in bold face indicate illustrations.

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